US009200398B2

(12) **United States Patent**
Poy

(10) **Patent No.: US 9,200,398 B2**
(45) **Date of Patent: Dec. 1, 2015**

(54) **CONTINUOUS BATCH TUNNEL WASHER AND METHOD**

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(72) Inventor: **Russell H. Poy**, New Orleans, LA (US)

(73) Assignee: **PELLERIN MILNOR CORPORATION**, Kenner, LA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/971,336**

(22) Filed: **Aug. 20, 2013**

(65) **Prior Publication Data**

US 2014/0053343 A1 Feb. 27, 2014

Related U.S. Application Data

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(51) **Int. Cl.**
D06F 35/00 (2006.01)
D06F 31/00 (2006.01)

(52) **U.S. Cl.**
CPC ***D06F 31/00*** (2013.01); ***D06F 31/005*** (2013.01)

(58) **Field of Classification Search**
CPC D06F 31/005; D06F 31/00; D06F 3/28; B22F 2999/00; B22F 2202/13
USPC ..... 8/158, 159, 137, 147; 68/27, 58, 143, 68/207, 140, 24, 5 D, 9, 145; 134/64 R, 10, 134/111, 122 R, 26, 120, 131, 152
See application file for complete search history.

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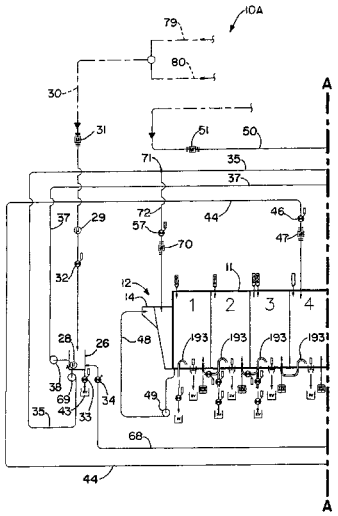
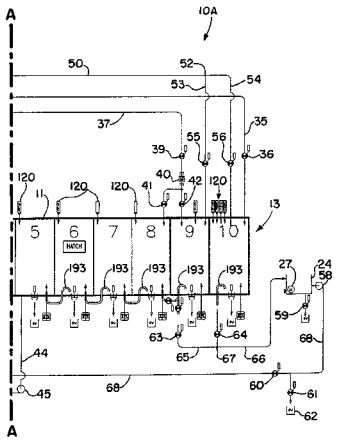
Primary Examiner — Michael Barr
Assistant Examiner — Thomas Bucci
(74) *Attorney, Agent, or Firm* — Garvey, Smith, Nehrbass & North, L.L.C.; Charles C. Garvey, Jr.; Vanessa M. D'Souza

(57) **ABSTRACT**

A method of washing fabric articles in a tunnel washer that includes moving the fabric articles from the intake of the washer to the discharge of the washer and through multiple modules or sectors. Liquid can be counter flowed in the washer interior along a flow path that is generally opposite the direction of travel of the fabric articles in order to rinse the fabric articles. While counterflow rinsing, the flow rate can be maintained at a selected flow rate or flow pressure head. One or more booster pumps can optionally be employed to maintain constant counterflow rinsing flow rate or constant counterflow rinsing pressure head. A source of fresh, make-up water can be provided to adjust conductivity. Conductivity is monitored in at least one of the modules. Conductivity of fluid in the discharged fabric articles is monitored. Make up water is added to one or more modules before if the conductivity of water in the discharged fabric articles exceeds a threshold value. In one embodiment, one of the modules is an empty pocket that is drained of fluid when rinsing with counterflowing liquid.

35 Claims, 27 Drawing Sheets





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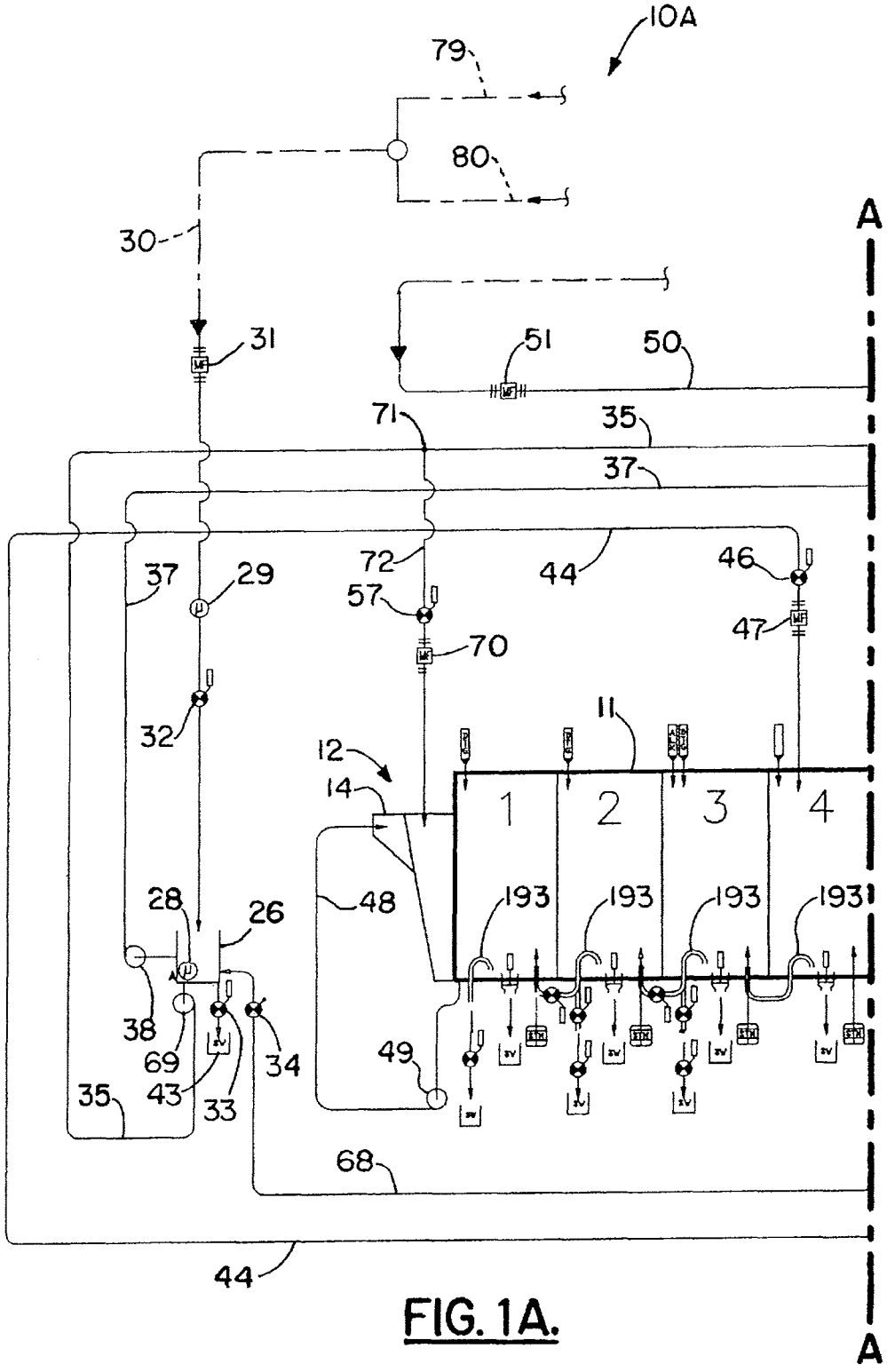
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79
80
30
31
51
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71
35
37
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72
44
46
57
47
70
32
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12
14
1
2
3
4
28
26
48
193
193
193
193
38
69
43
33
34
49
35
68
44
A
A

FIG. 1A.

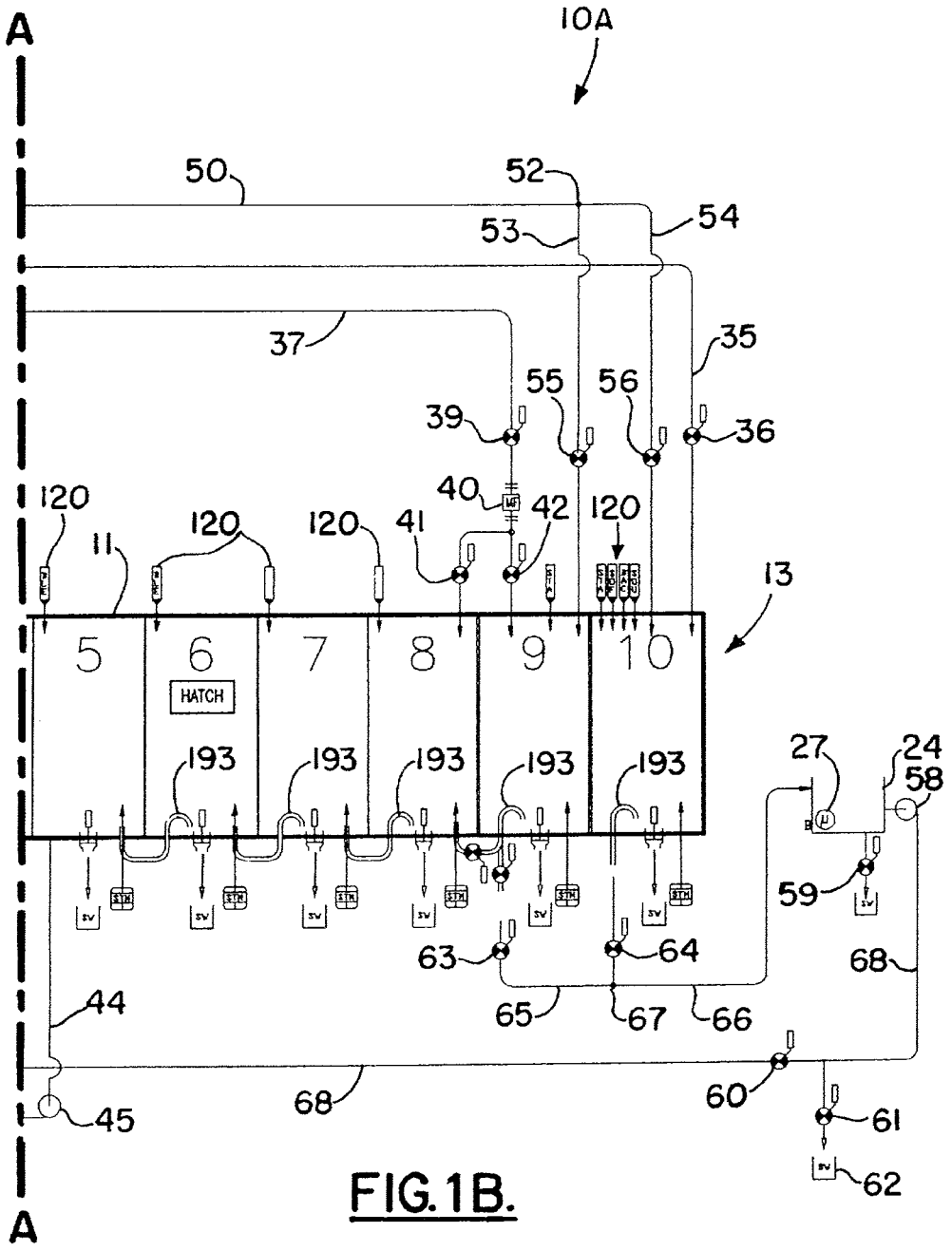

A
10A
50
52
53
54
37
35
55
56
39
36
40
42
120
41
11
13
5
6
HATCH
7
8
9
10
193
27
24
58
59
63
64
68
44
65
67
66
45
60
61
62
A

FIG. 1B.

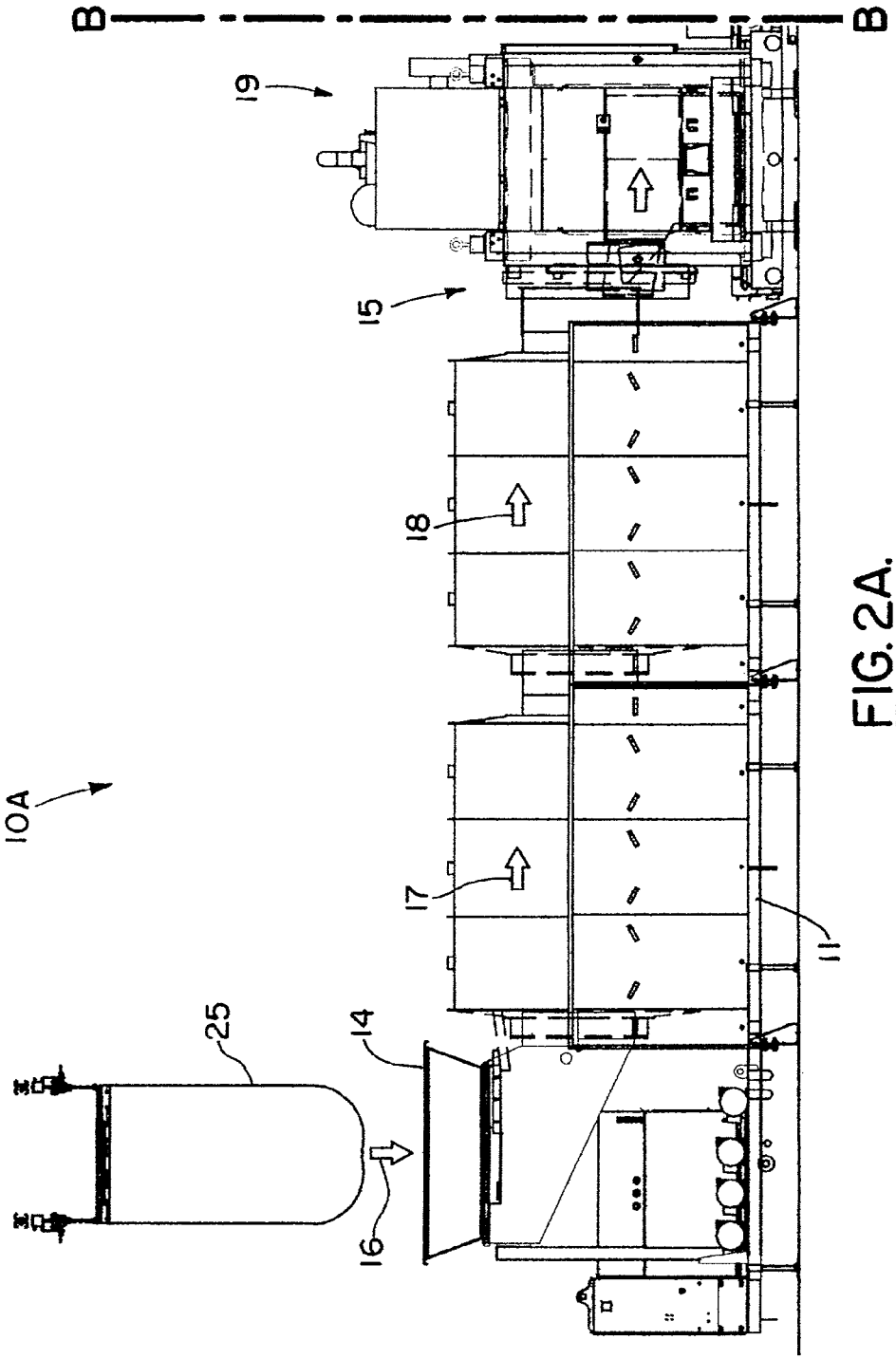


FIG. 2A.

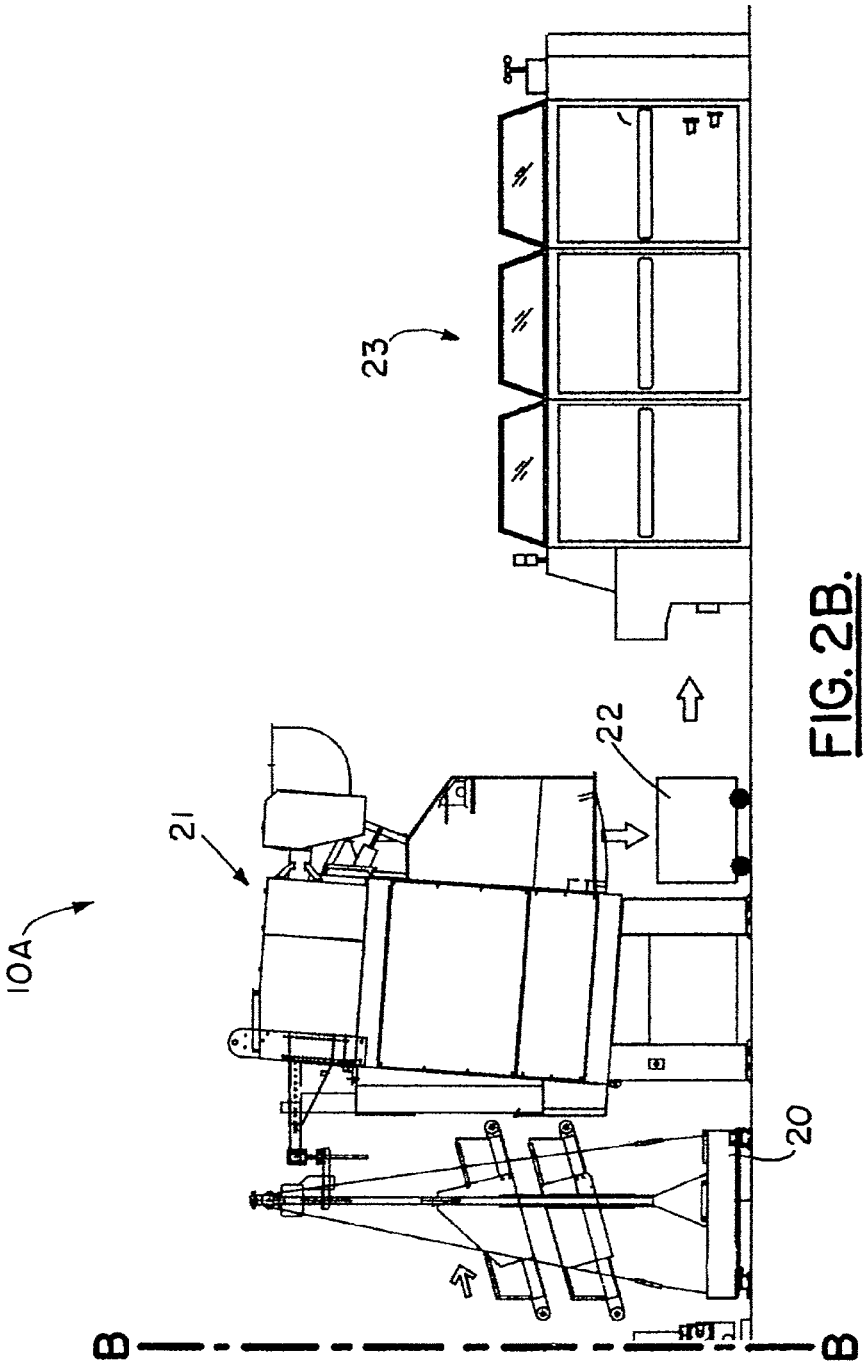


FIG. 2B.

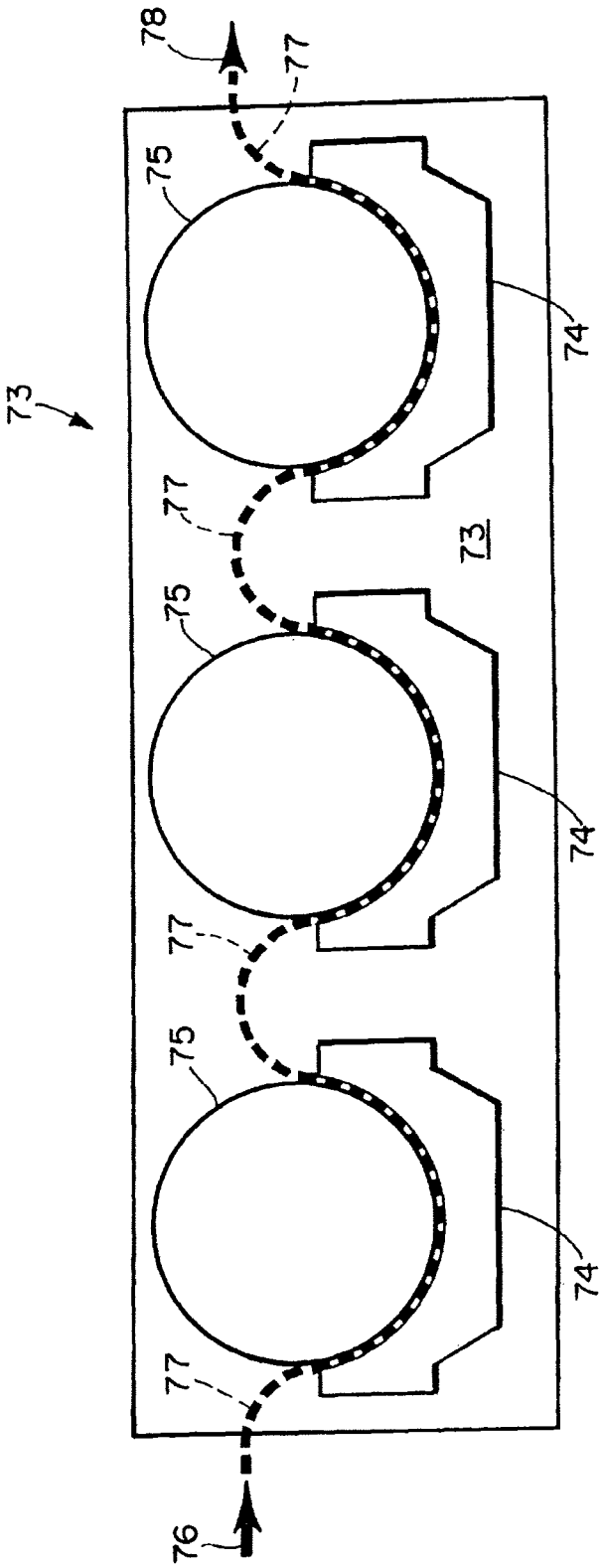
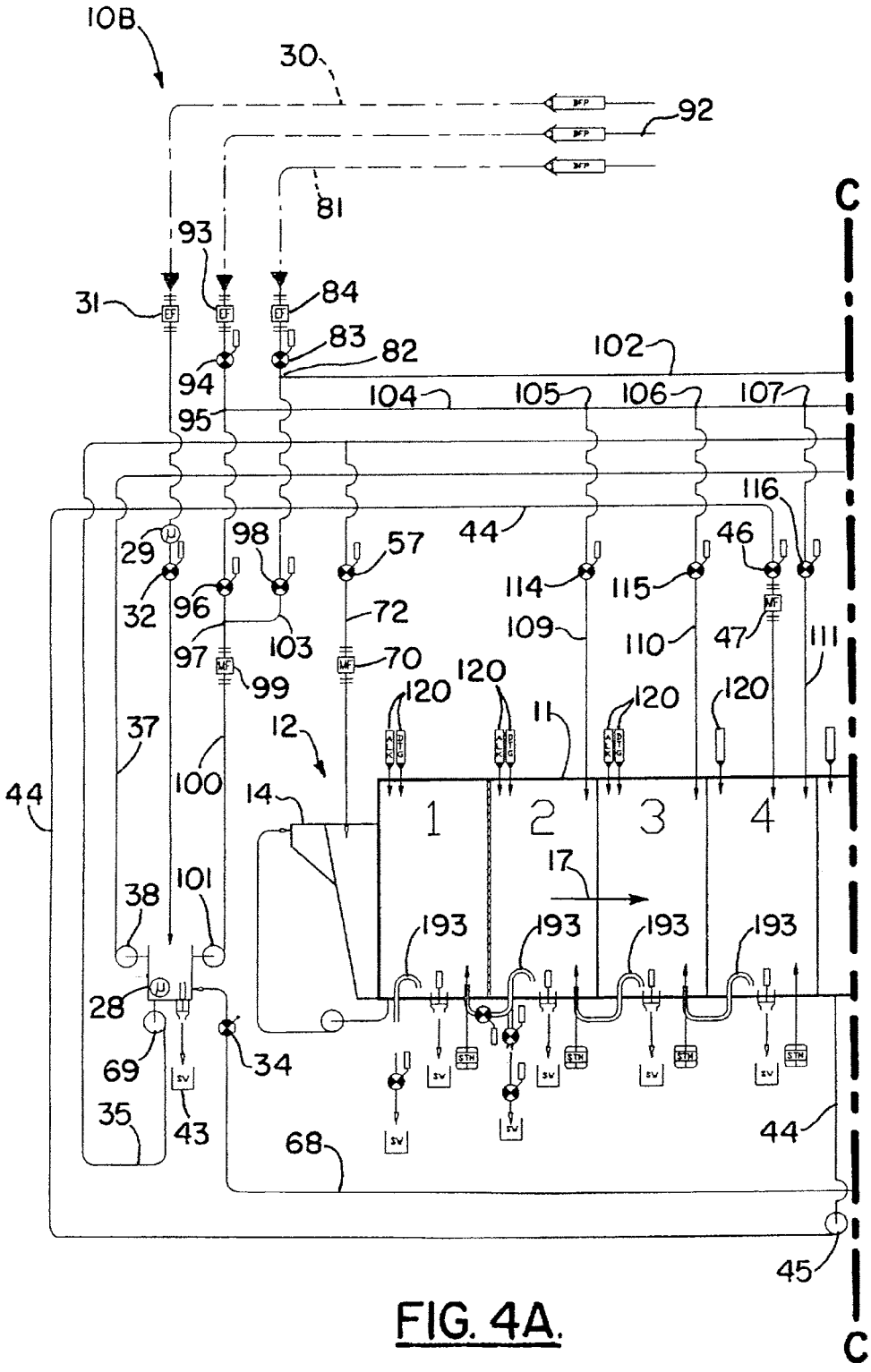


FIG. 3.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30
92
81
C
93
31
84
83
82
102
94
104
105
106
107
95
116
44
29
98
57
46
114
115
32
96
72
109
110
47
111
97
103
70
99
120
120
120
120
11
37
12
100
14
44
1
2
3
4
17
38
101
193
193
193
193
28
69
34
35
43
68
44
45
C

FIG. 4A.

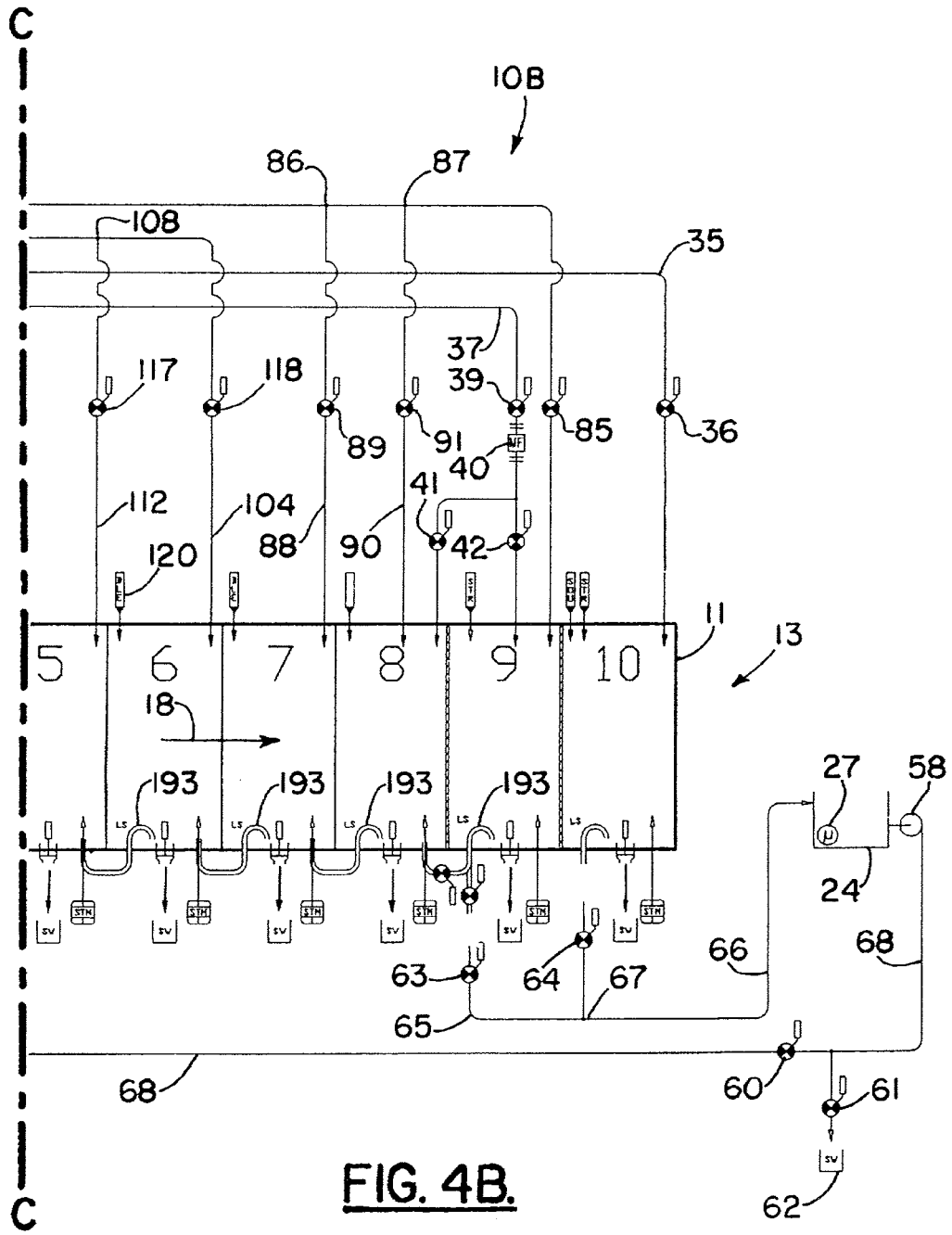
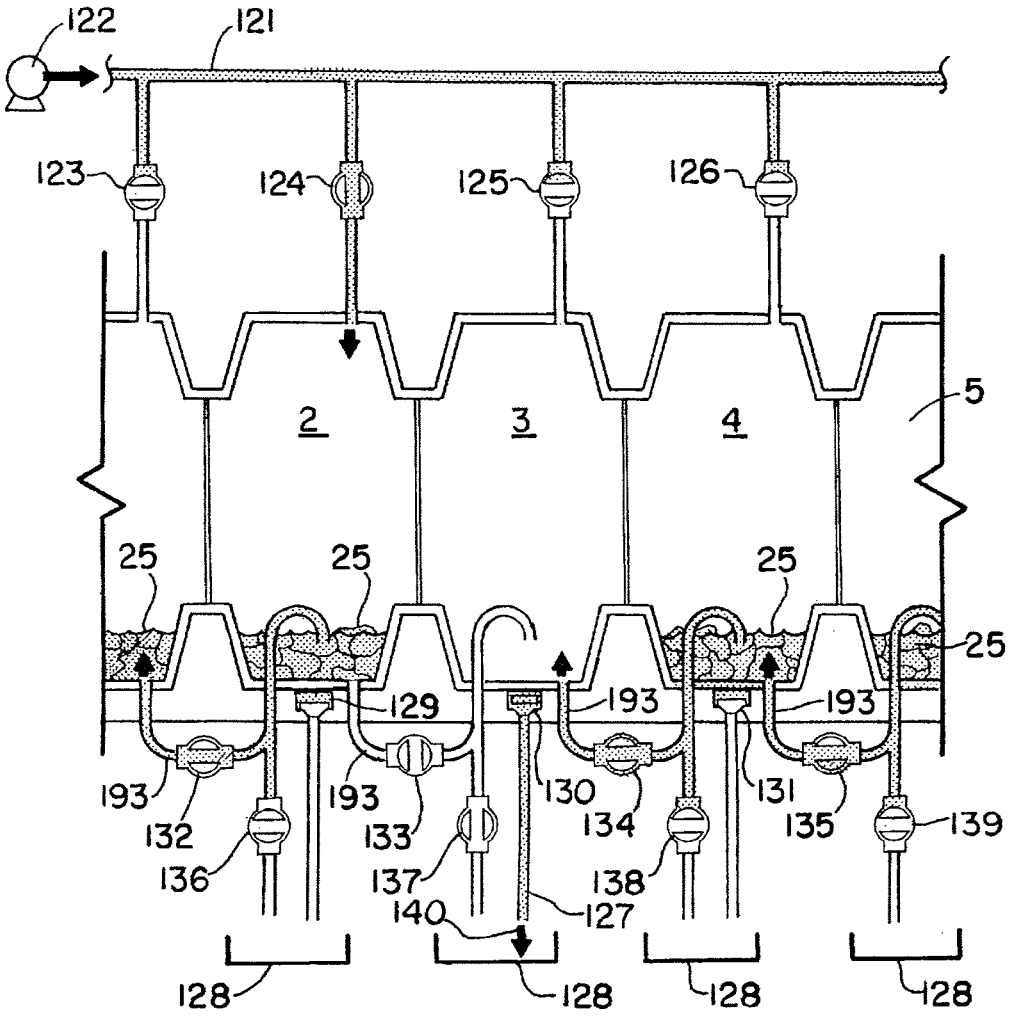

C
108
86
87
108
35
37
117
118
39
89
91
85
36
40
41
112
104
88
90
42
120
11
13
5
6
7
8
9
10
18
193
193
193
193
27
58
24
66
68
63
64
67
65
68
60
61
62
C

FIG. 4B.


122
121
123
124
125
126
2
3
4
5
25
25
25
25
129
193
193
193
193
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132
133
134
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136
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138
139
140
127
128
128
128
128

FIG. 5.

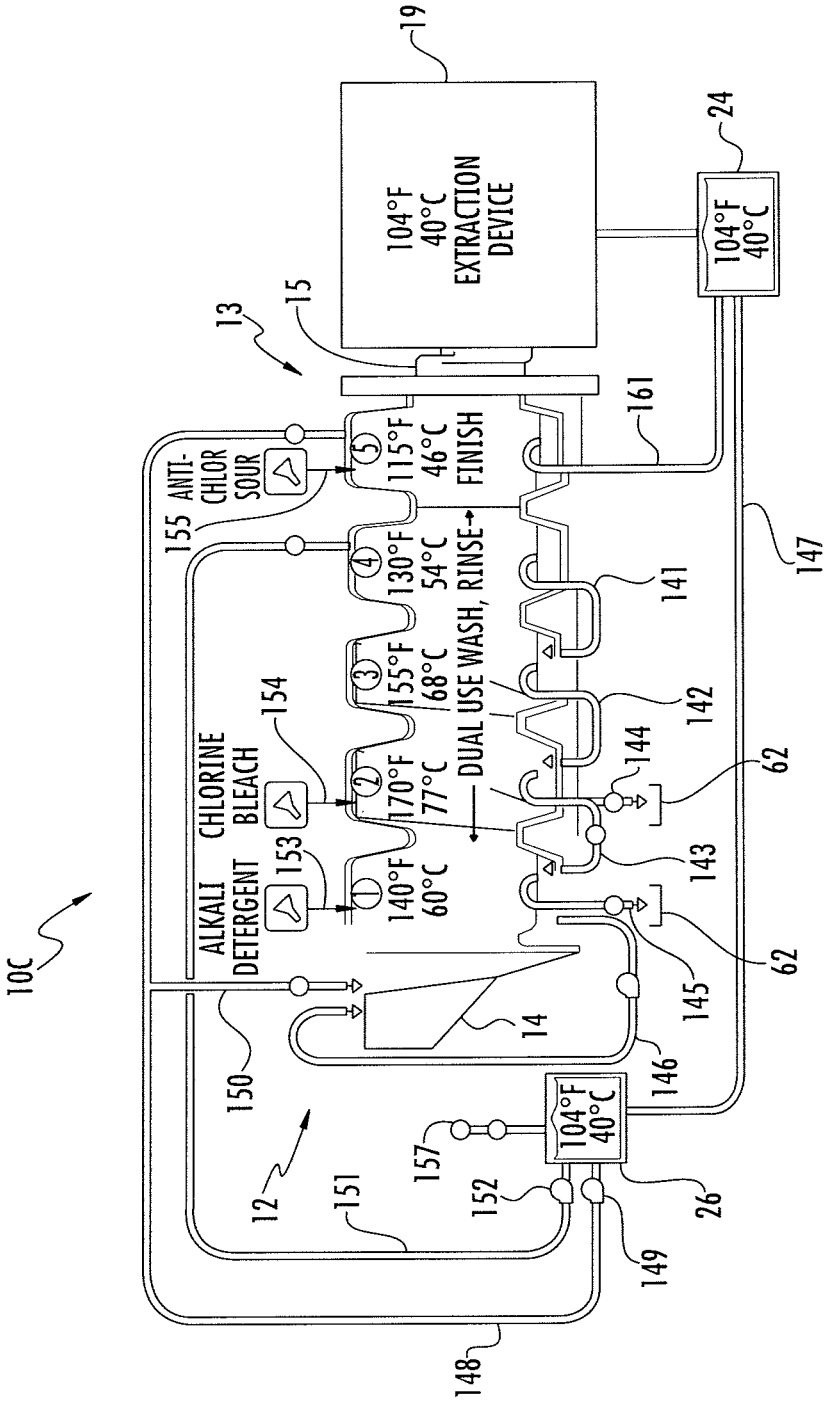
10C
ALKALI DETERGENT
CHLORINE BLEACH
ANTI-CHLOR SOUR
DUAL USE WASH, RINSE
FINISH
140°F 60°C
170°F 77°C
155°F 68°C
130°F 54°C
115°F 46°C
104°F 40°C EXTRACTION DEVICE
104°F 40°C
104°F 40°C
12
13
14
15
19
24
26
62
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
157
161

FIG. 6

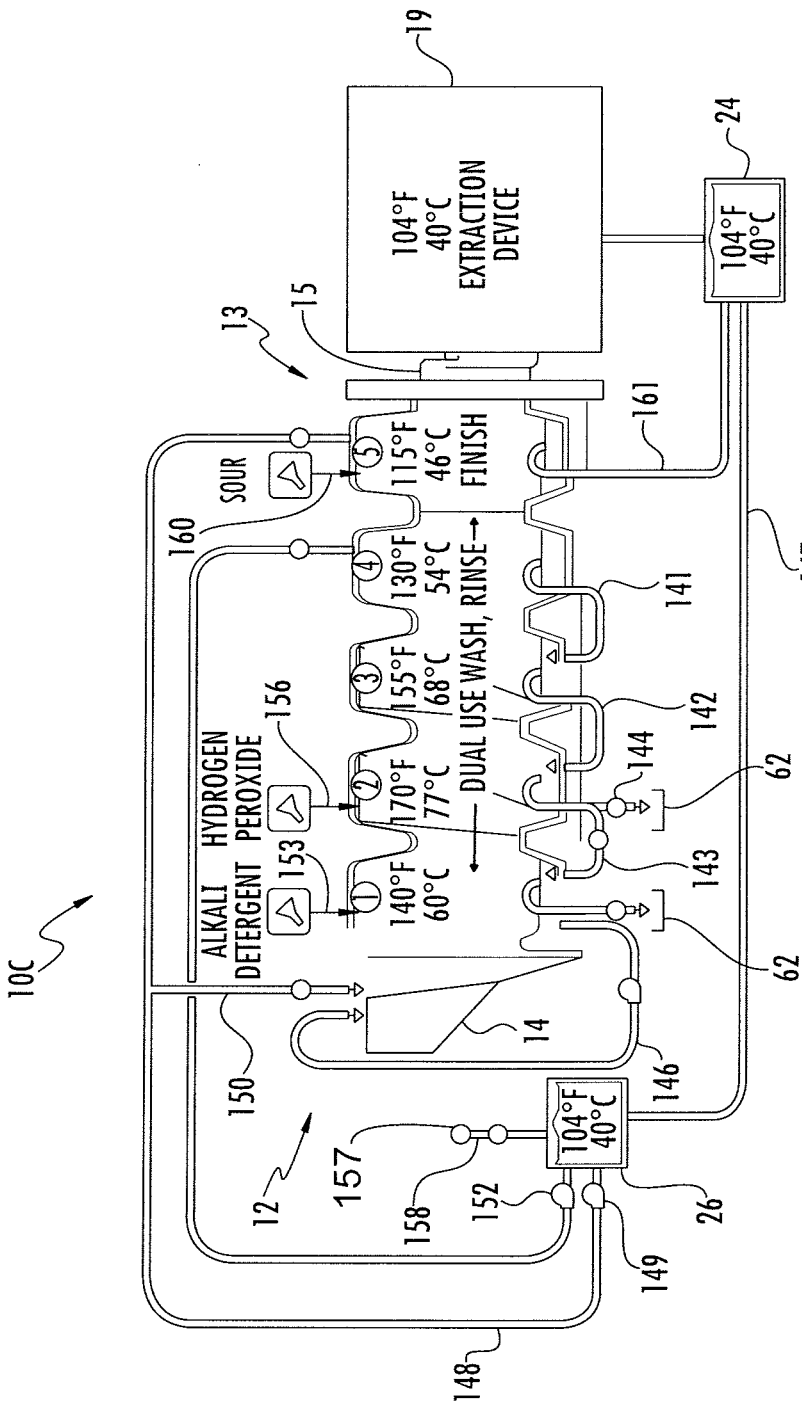
10C
ALKALI DETERGENT
HYDROGEN PEROXIDE
SOUR
FINISH
DUAL USE WASH, RINSE
140°F 60°C
170°F 77°C
155°F 68°C
130°F 54°C
115°F 46°C
104°F 40°C EXTRACTION DEVICE
104°F 40°C
104°F 40°C
12
13
14
15
19
24
26
62
141
142
143
144
146
147
148
149
150
152
153
156
157
158
160
161

FIG. 7

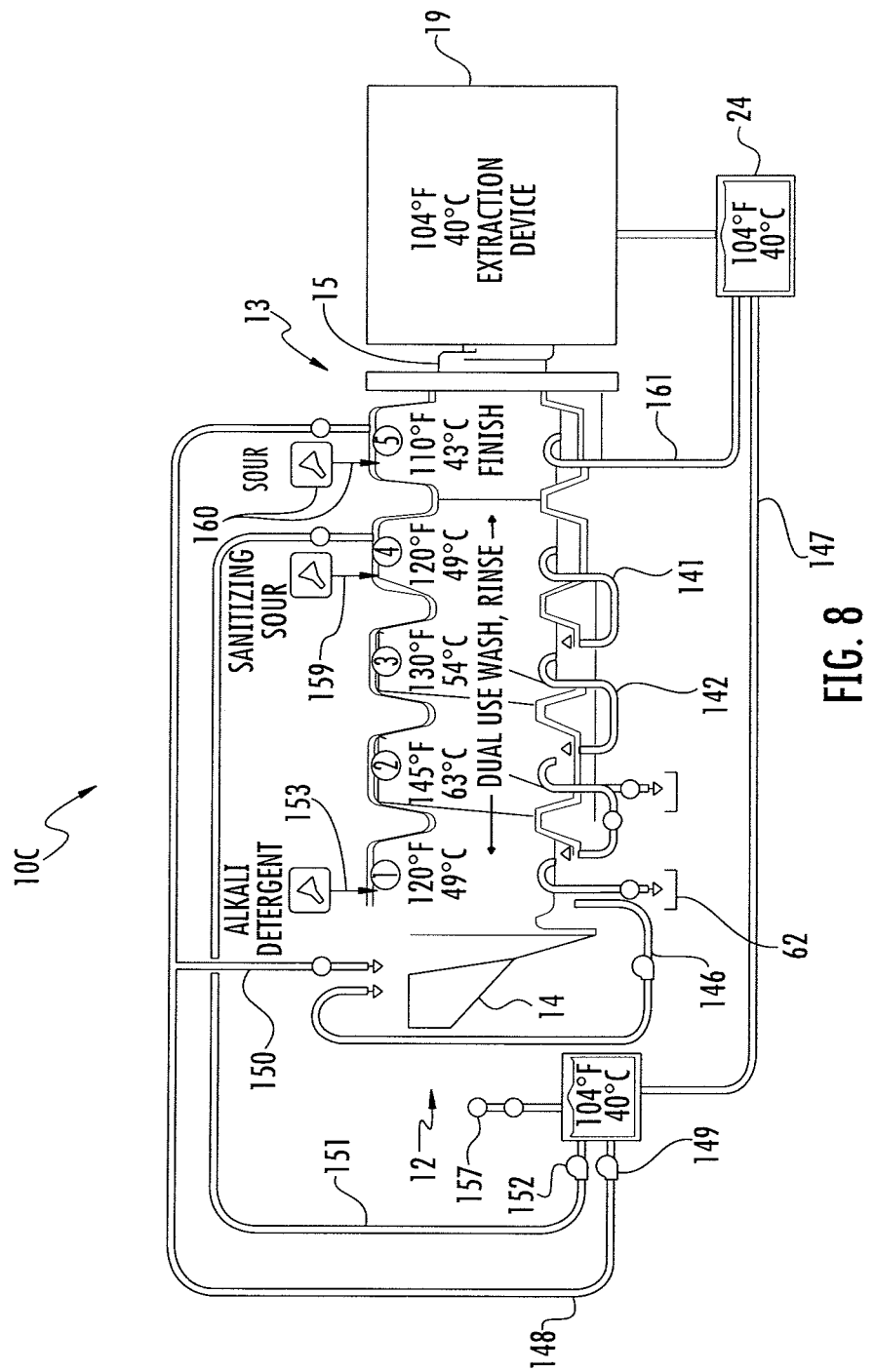
10C
19
104°F
40°C
EXTRACTION
DEVICE
24
104°F
40°C
13
15
161
SOUR
160
110°F
43°C
FINISH
SANITIZING
SOUR
159
120°F
49°C
130°F
54°C
145°F
63°C
120°F
49°C
DUAL USE WASH, RINSE
141
142
147
ALKALI
DETERGENT
153
62
146
14
150
104°F
40°C
12
157
152
149
151
148

FIG. 8

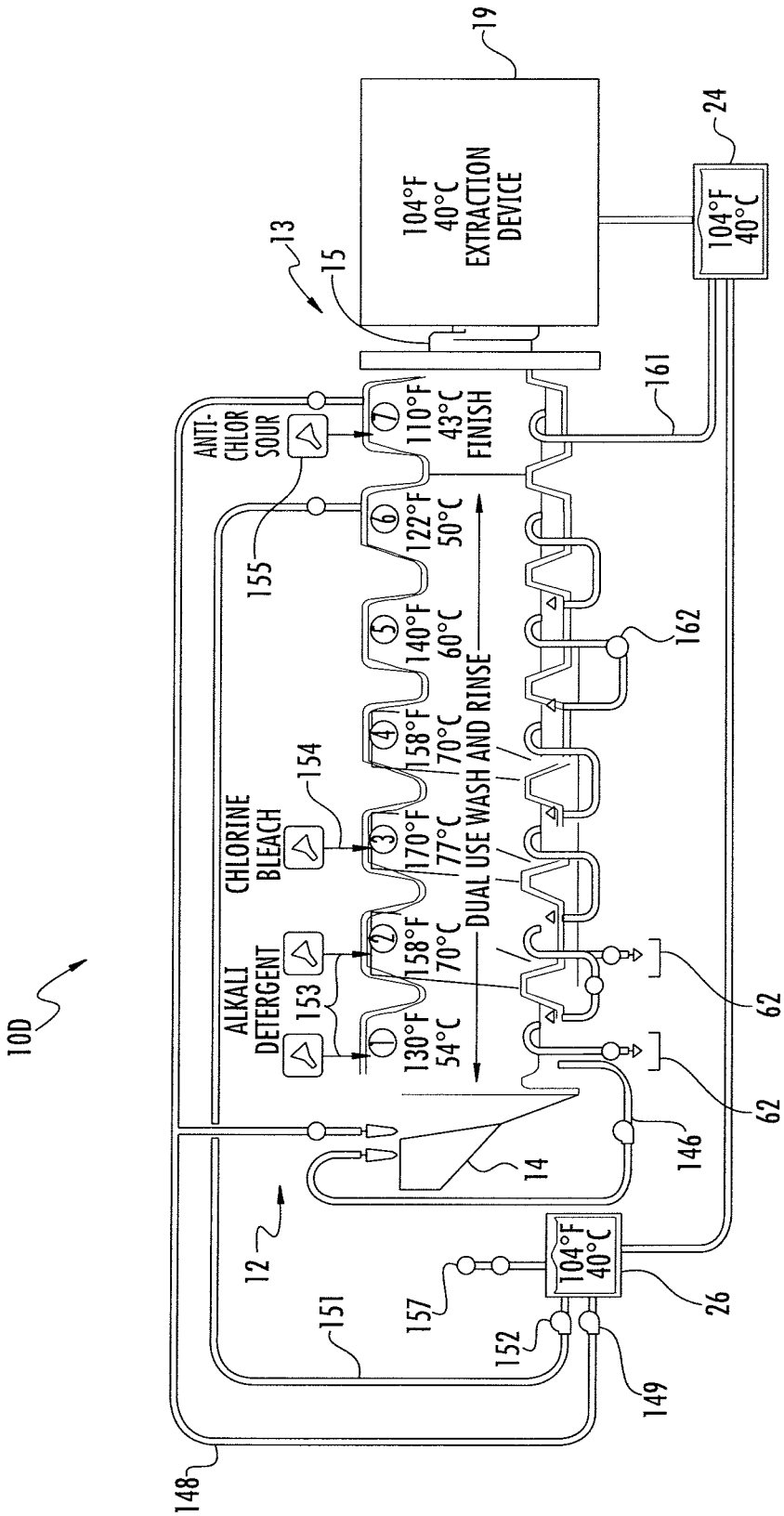
10D
19
104°F
40°C
EXTRACTION
DEVICE
13
15
24
104°F
40°C
161
ANTI-
CHLOR
SOUR
155
110°F
43°C
FINISH
122°F
50°C
140°F
60°C
158°F
70°C
DUAL USE WASH AND RINSE
162
154
CHLORINE
BLEACH
170°F
77°C
158°F
70°C
ALKALI
DETERGENT
153
130°F
54°C
62
62
146
14
12
104°F
40°C
26
157
151
152
149
148

FIG. 9

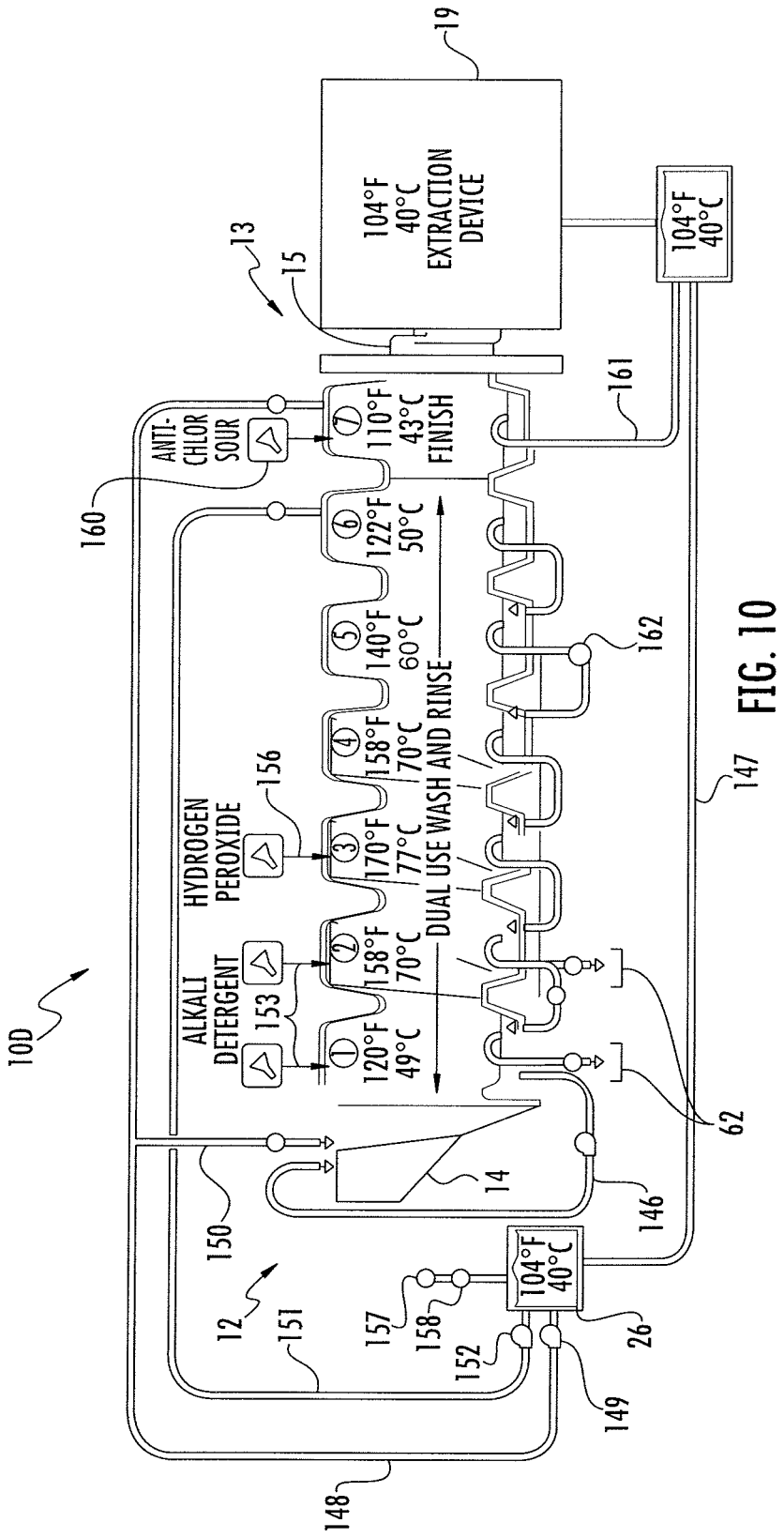
10D
19
104°F
40°C
EXTRACTION
DEVICE
13
15
104°F
40°C
161
ANTI-
CHLOR
SOUR
160
7
110°F
43°C
FINISH
6
122°F
50°C
5
140°F
60°C
4
158°F
70°C
3
170°F
77°C
2
158°F
70°C
1
120°F
49°C
DUAL USE WASH AND RINSE
162
147
HYDROGEN
PEROXIDE
156
ALKALI
DETERGENT
153
62
14
146
150
12
151
157
158
152
104°F
40°C
26
149
148

FIG. 10

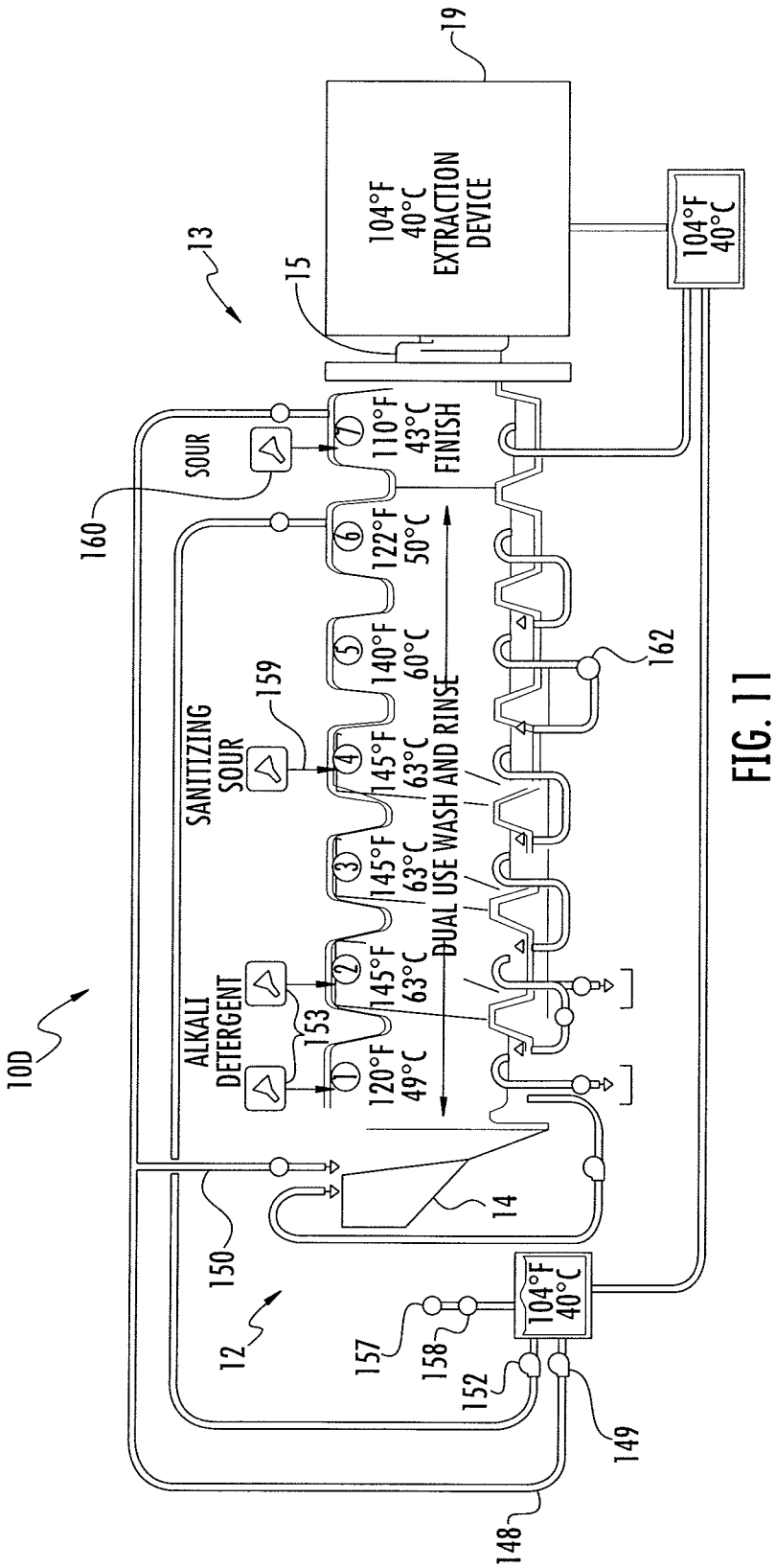
10D
19
104°F
40°C
EXTRACTION
DEVICE
13
15
104°F
40°C
160
SOUR
110°F
43°C
FINISH
122°F
50°C
140°F
60°C
162
159
SANITIZING
SOUR
145°F
63°C
145°F
63°C
DUAL USE WASH AND RINSE
145°F
63°C
153
ALKALI
DETERGENT
120°F
49°C
14
150
12
104°F
40°C
157
158
152
149
148

FIG. 11

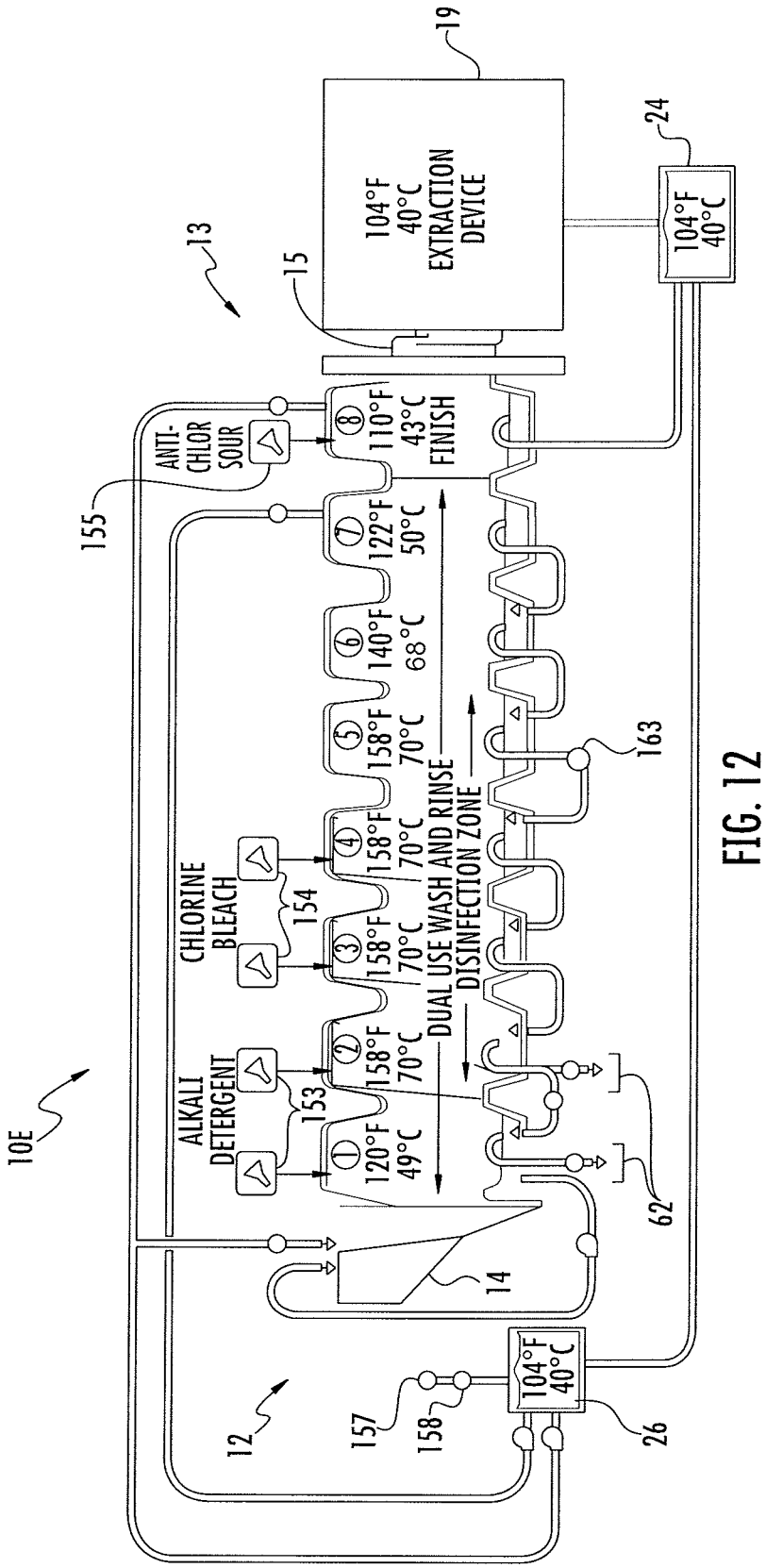
10E
12
13
14
15
19
24
26
62
104°F
40°C
EXTRACTION
DEVICE
104°F
40°C
104°F
40°C
ANTI-
CHLOR
SOUR
155
ALKALI
DETERGENT
153
CHLORINE
BLEACH
154
DUAL USE WASH AND RINSE
DISINFECTION ZONE
① 120°F 49°C
② 158°F 70°C
③ 158°F 70°C
④ 158°F 70°C
⑤ 158°F 70°C
⑥ 140°F 68°C
⑦ 122°F 50°C
⑧ 110°F 43°C
FINISH
157
158
163

FIG. 12

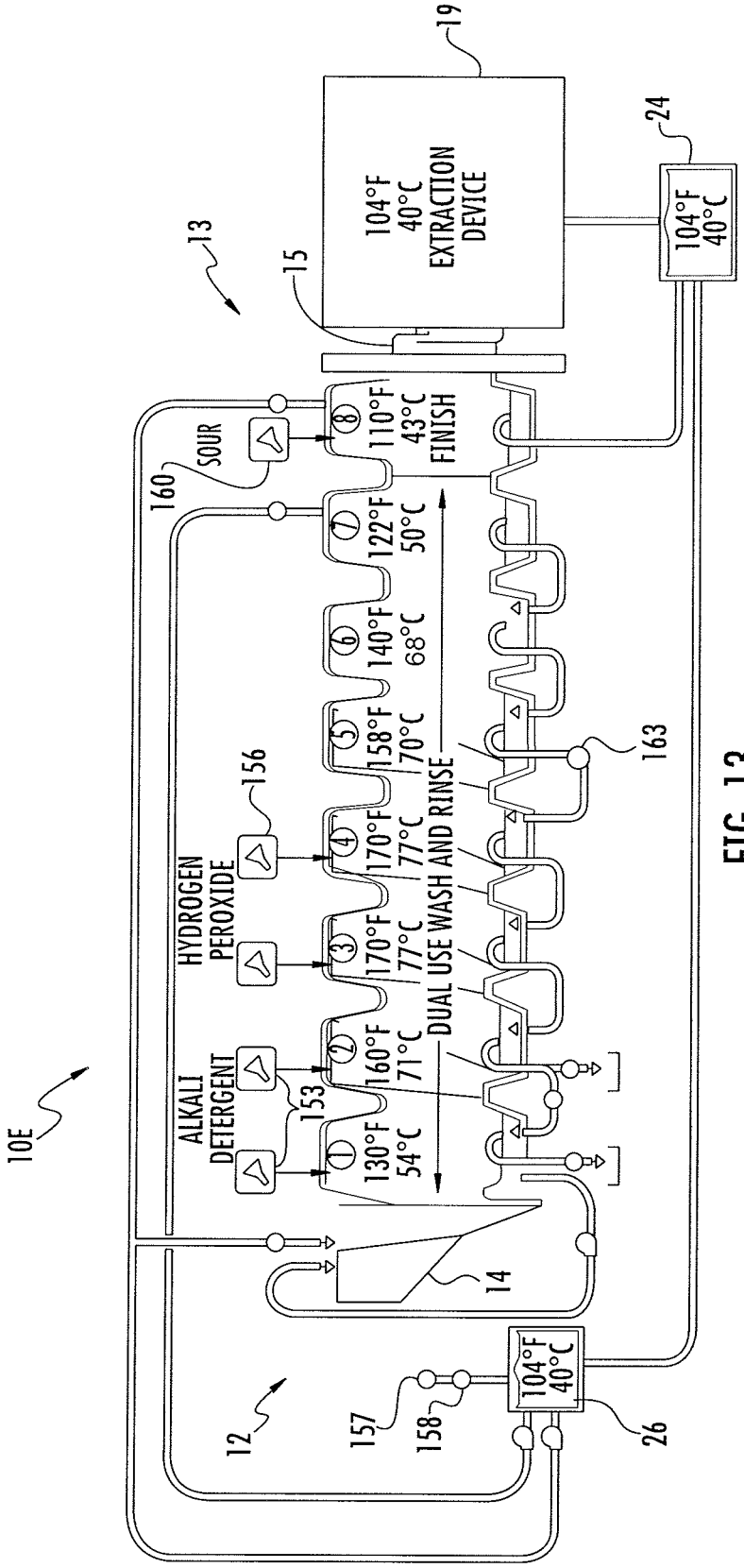
10E
12
13
14
15
19
24
26
104°F
40°C
EXTRACTION
DEVICE
104°F
40°C
104°F
40°C
ALKALI
DETERGENT
HYDROGEN
PEROXIDE
SOUR
FINISH
DUAL USE WASH AND RINSE
130°F
54°C
160°F
71°C
170°F
77°C
170°F
77°C
158°F
70°C
140°F
68°C
122°F
50°C
110°F
43°C
153
156
157
158
160
163

FIG. 13

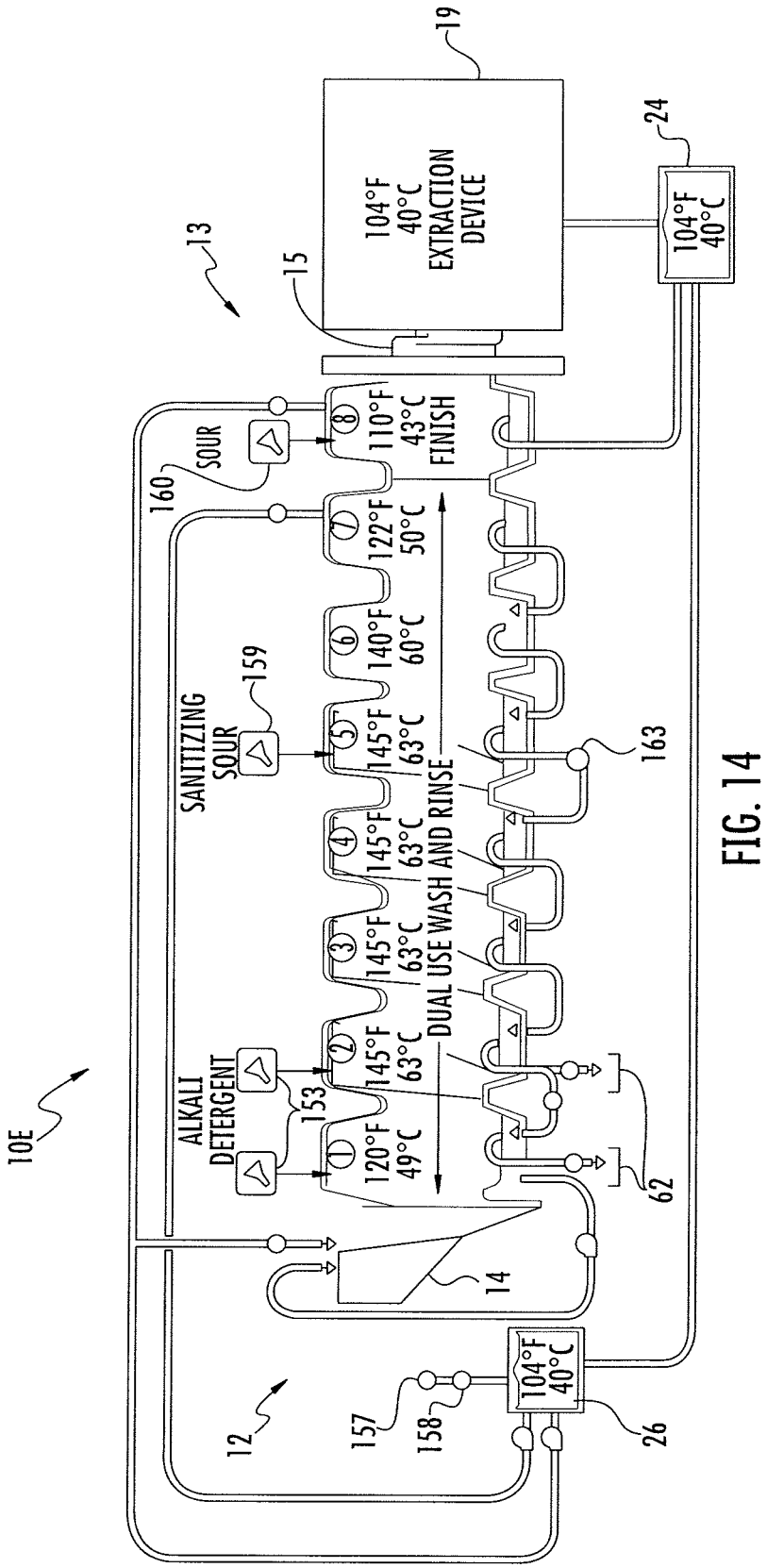
10E
12
13
14
15
19
24
26
62
104°F
40°C
EXTRACTION
DEVICE
104°F
40°C
104°F
40°C
157
158
160
SOUR
153
ALKALI
DETERGENT
159
SANITIZING
SOUR
163
DUAL USE WASH AND RINSE
1
120°F
49°C
2
145°F
63°C
3
145°F
63°C
4
145°F
63°C
5
145°F
63°C
6
140°F
60°C
7
122°F
50°C
8
110°F
43°C
FINISH

FIG. 14

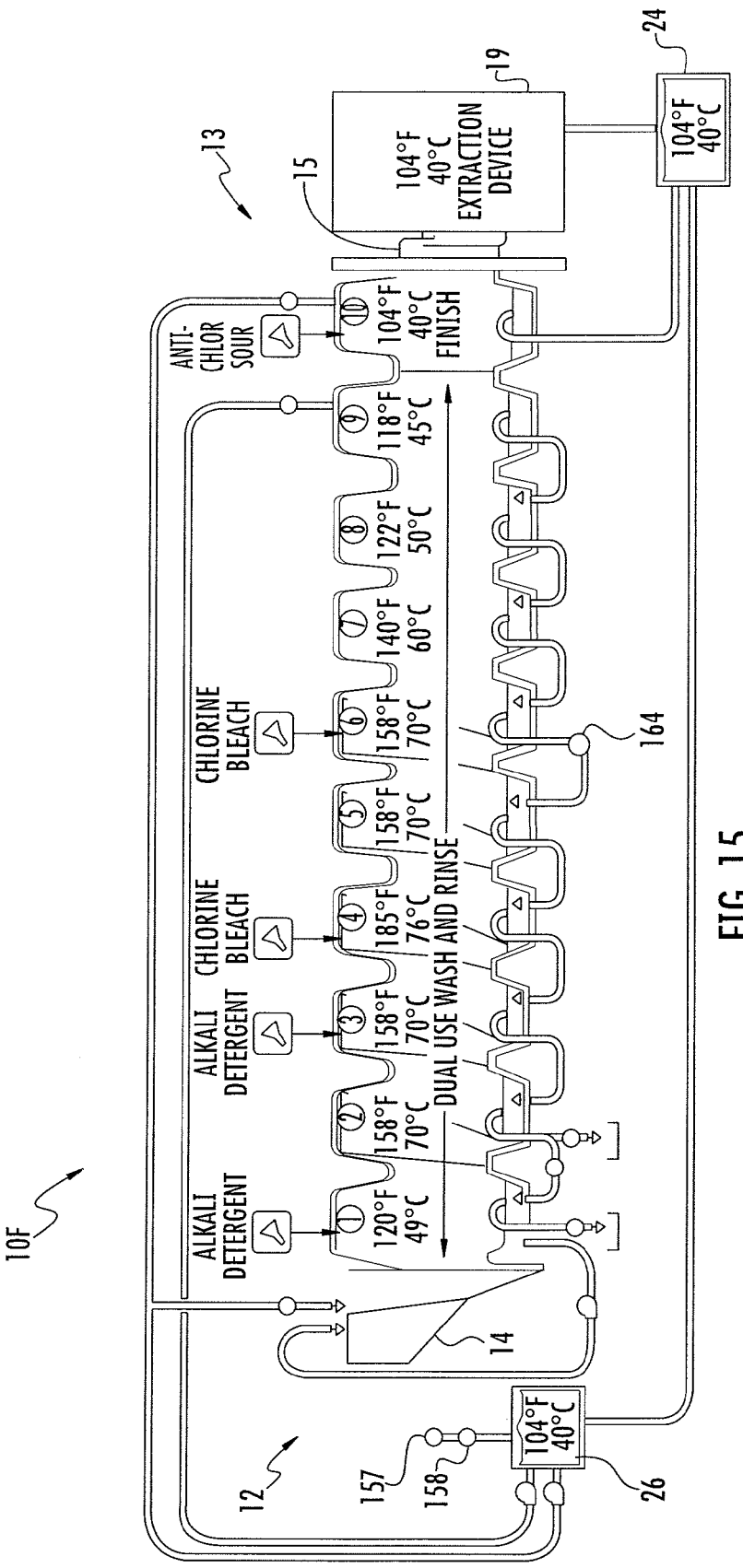
10F
12
13
14
15
19
24
26
157
158
164
104°F 40°C EXTRACTION DEVICE
104°F 40°C
104°F 40°C
ANTI-CHLOR SOUR
ALKALI DETERGENT
CHLORINE BLEACH
ALKALI DETERGENT
CHLORINE BLEACH
DUAL USE WASH AND RINSE
FINISH
120°F 49°C
158°F 70°C
158°F 70°C
185°F 76°C
158°F 70°C
158°F 70°C
140°F 60°C
122°F 50°C
118°F 45°C
104°F 40°C

FIG. 15

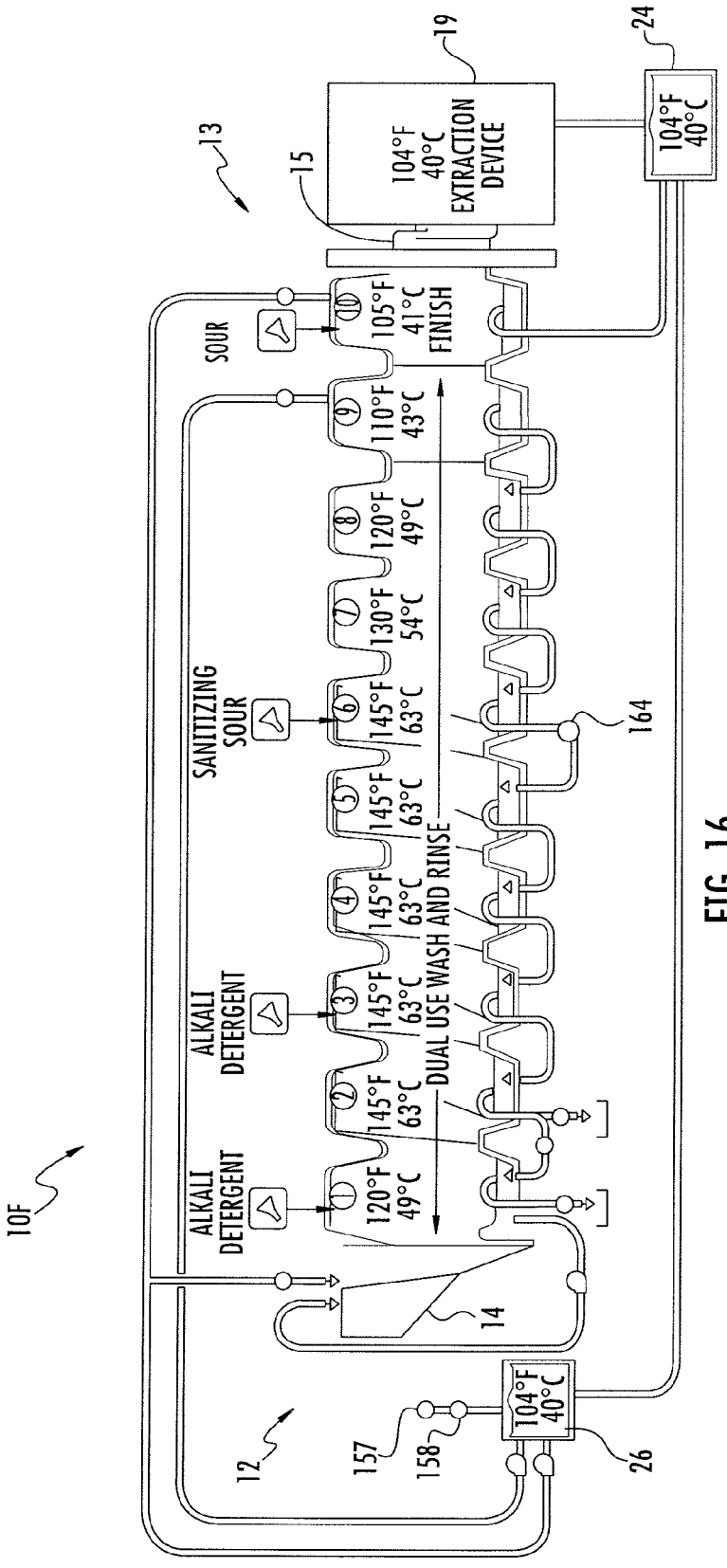
10F
13
15
19
104°F
40°C
EXTRACTION
DEVICE
24
104°F
40°C
SOUR
105°F
41°C
FINISH
110°F
43°C
120°F
49°C
130°F
54°C
SANITIZING
SOUR
145°F
63°C
ALKALI
DETERGENT
DUAL USE WASH AND RINSE
ALKALI
DETERGENT
164
14
12
157
158
104°F
40°C
26

FIG. 16

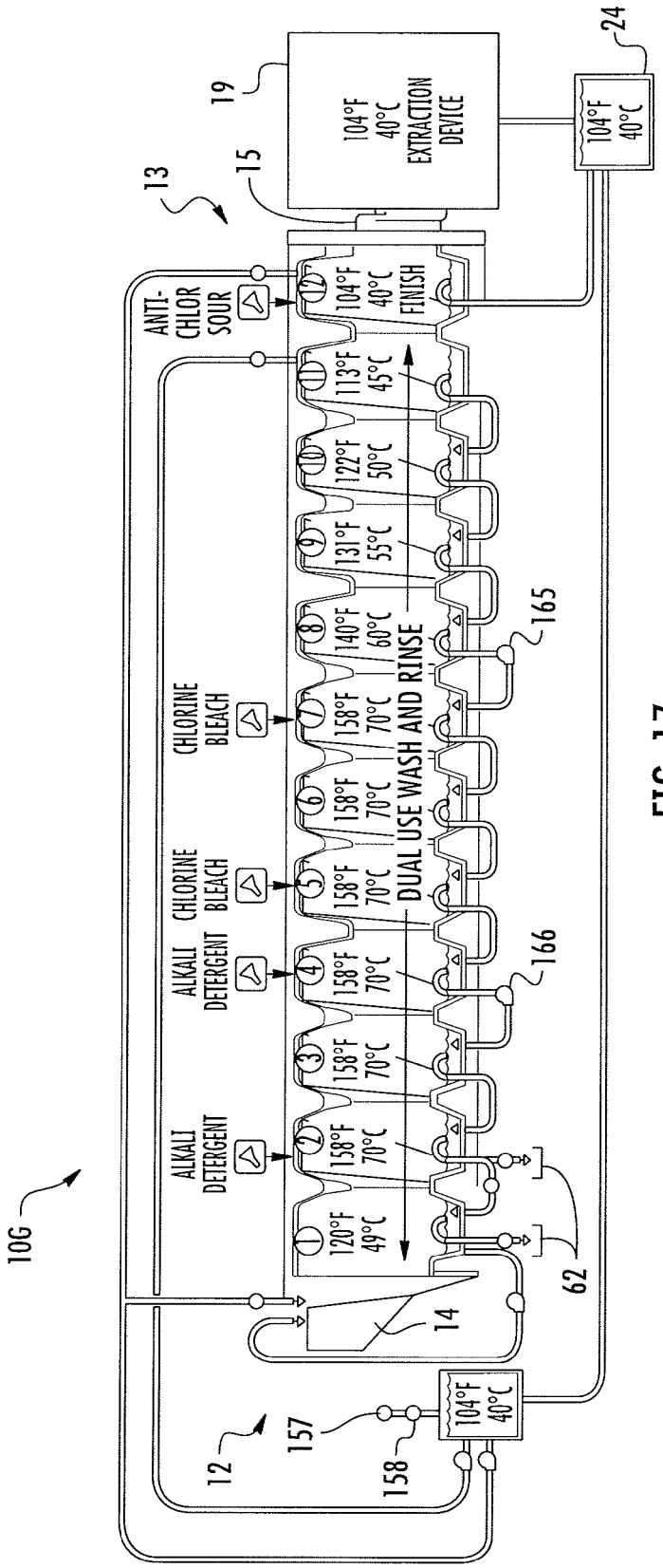
104°F
40°C
EXTRACTION
DEVICE
19
24
104°F
40°C
13
15
ANTI-
CHLOR
SOUR
104°F
40°C
FINISH
113°F
45°C
122°F
50°C
131°F
55°C
140°F
60°C
158°F
70°C
DUAL USE WASH AND RINSE
CHLORINE
BLEACH
ALKALI
DETERGENT
120°F
49°C
165
166
62
14
157
158
12
10G

FIG. 17

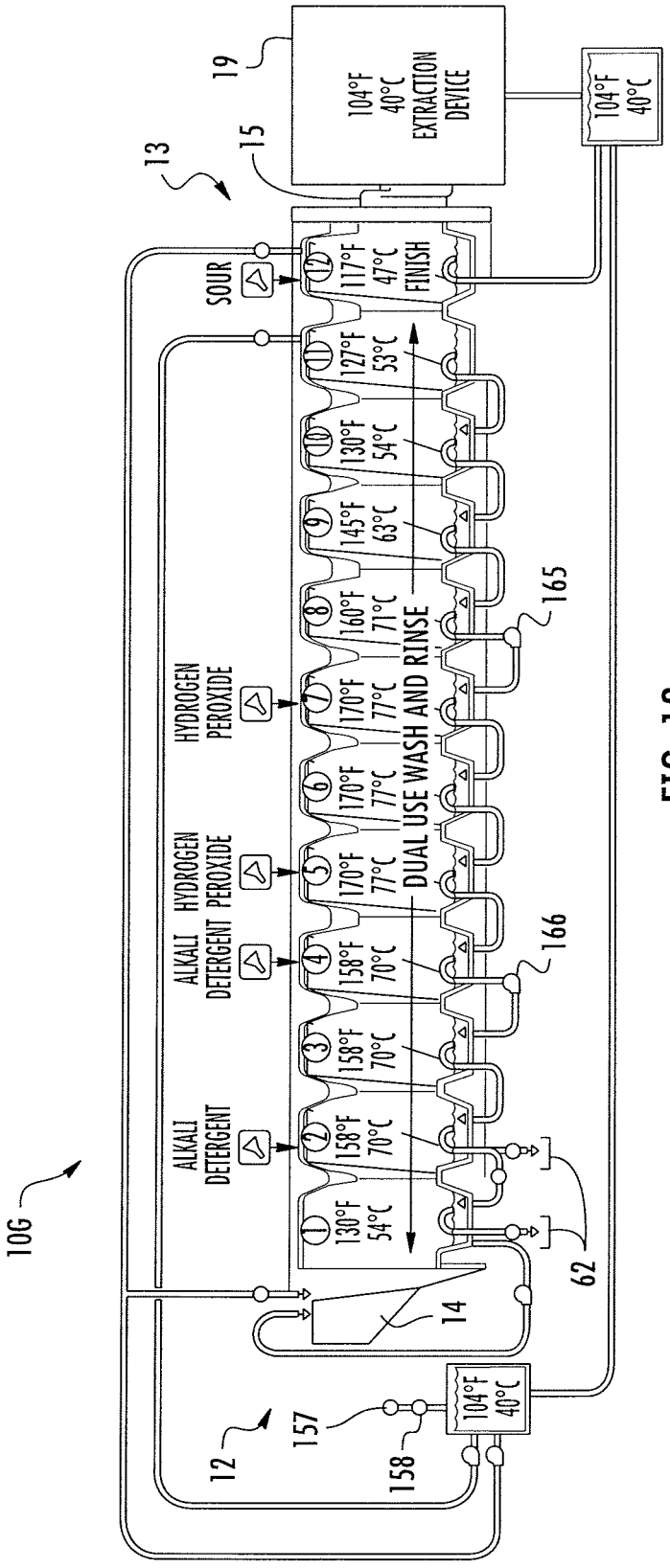
10G
12
13
14
15
19
62
104°F 40°C EXTRACTION DEVICE
104°F 40°C
104°F 40°C
157
158
165
166
SOUR
ALKALI DETERGENT
ALKALI DETERGENT
HYDROGEN PEROXIDE
HYDROGEN PEROXIDE
DUAL USE WASH AND RINSE
FINISH
1 130°F 54°C
2 158°F 70°C
3 158°F 70°C
4 158°F 70°C
5 170°F 77°C
6 170°F 77°C
7 170°F 77°C
8 160°F 71°C
9 145°F 63°C
10 130°F 54°C
11 127°F 53°C
12 117°F 47°C

FIG. 18

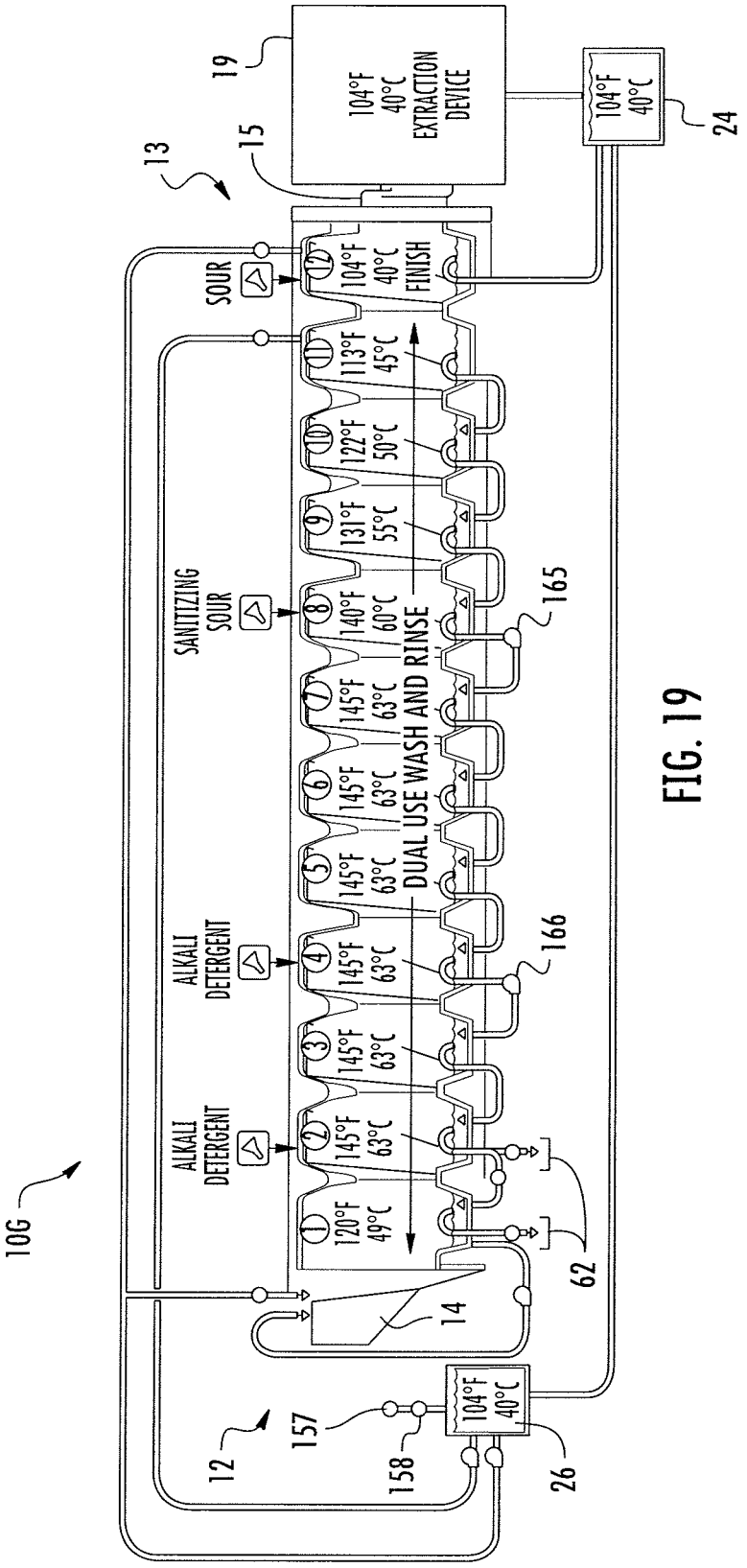
10G
12
13
14
15
19
24
26
62
104°F 40°C EXTRACTION DEVICE
104°F 40°C
104°F 40°C
SOUR
FINISH
113°F 45°C
122°F 50°C
131°F 55°C
SANITIZING SOUR
140°F 60°C
145°F 63°C
ALKALI DETERGENT
ALKALI DETERGENT
120°F 49°C
DUAL USE WASH AND RINSE
157
158
165
166

FIG. 19

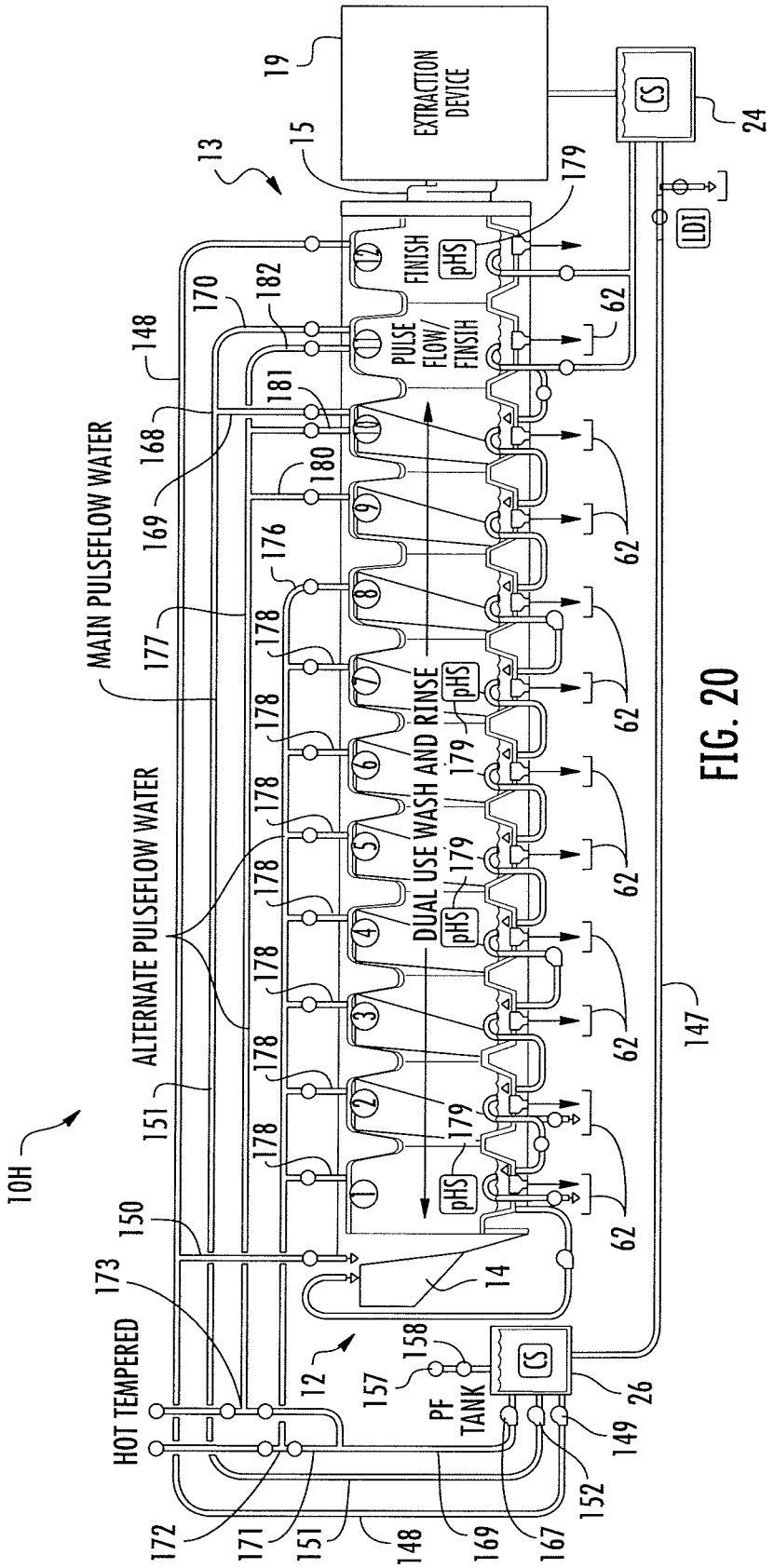
EXTRACTION DEVICE
19
15
13
24
CS
LDI
179
FINISH
pHS
PULSE FLOW/ FINSIH
62
182
170
148
181
168
169
180
176
177
178
MAIN PULSEFLOW WATER
ALTERNATE PULSEFLOW WATER
DUAL USE WASH AND RINSE
151
150
173
HOT TEMPERED
172
171
14
12
158
157
PF TANK
26
149
152
167
147
10H

FIG. 20

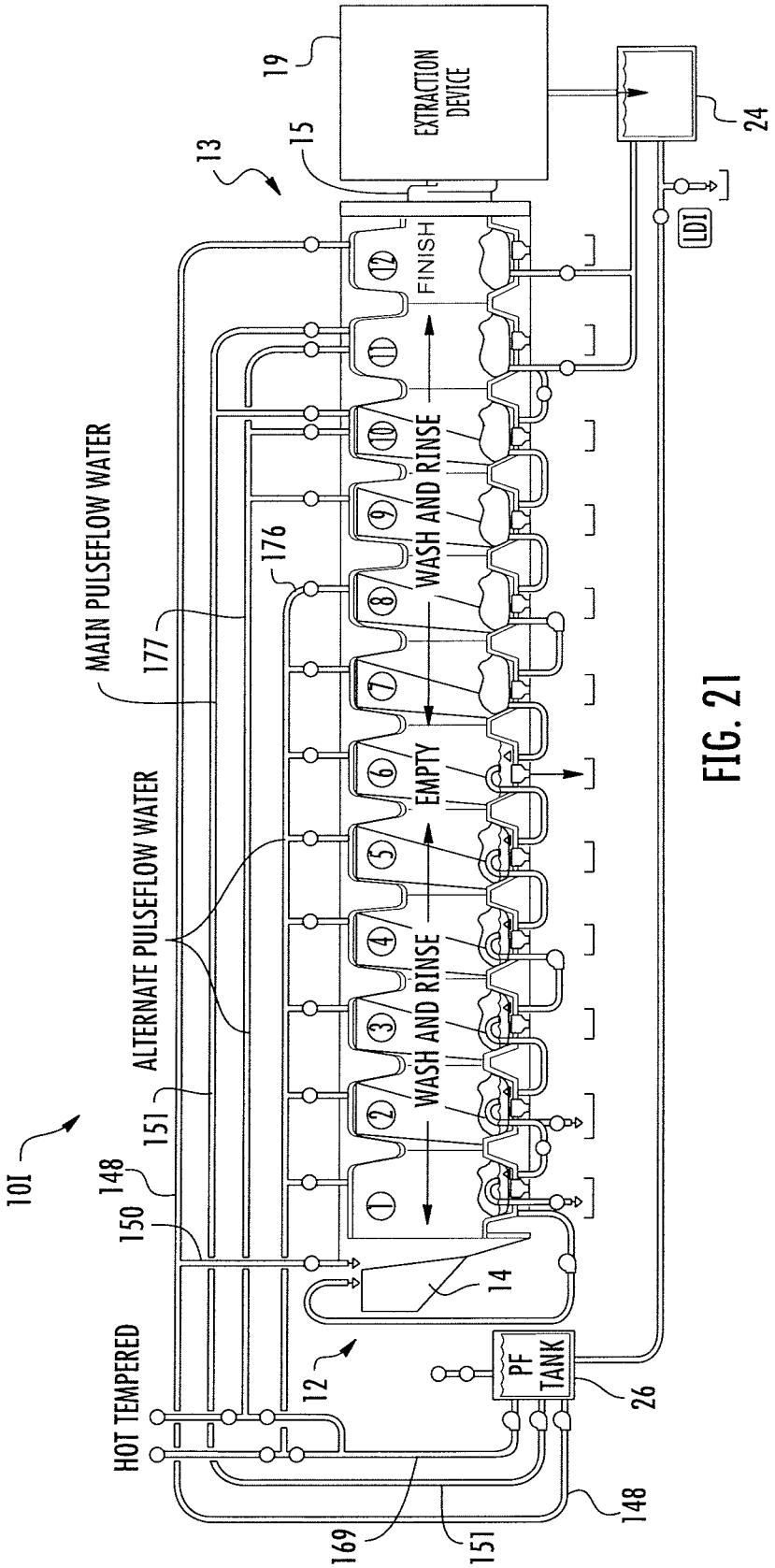
101
MAIN PULSEFLOW WATER
ALTERNATE PULSEFLOW WATER
HOT TEMPERED
EXTRACTION DEVICE
19
15
13
24
LDI
FINISH
WASH AND RINSE
EMPTY
WASH AND RINSE
WASH AND RINSE
176
177
151
148
150
14
12
PF TANK
26
169
151
148

FIG. 21

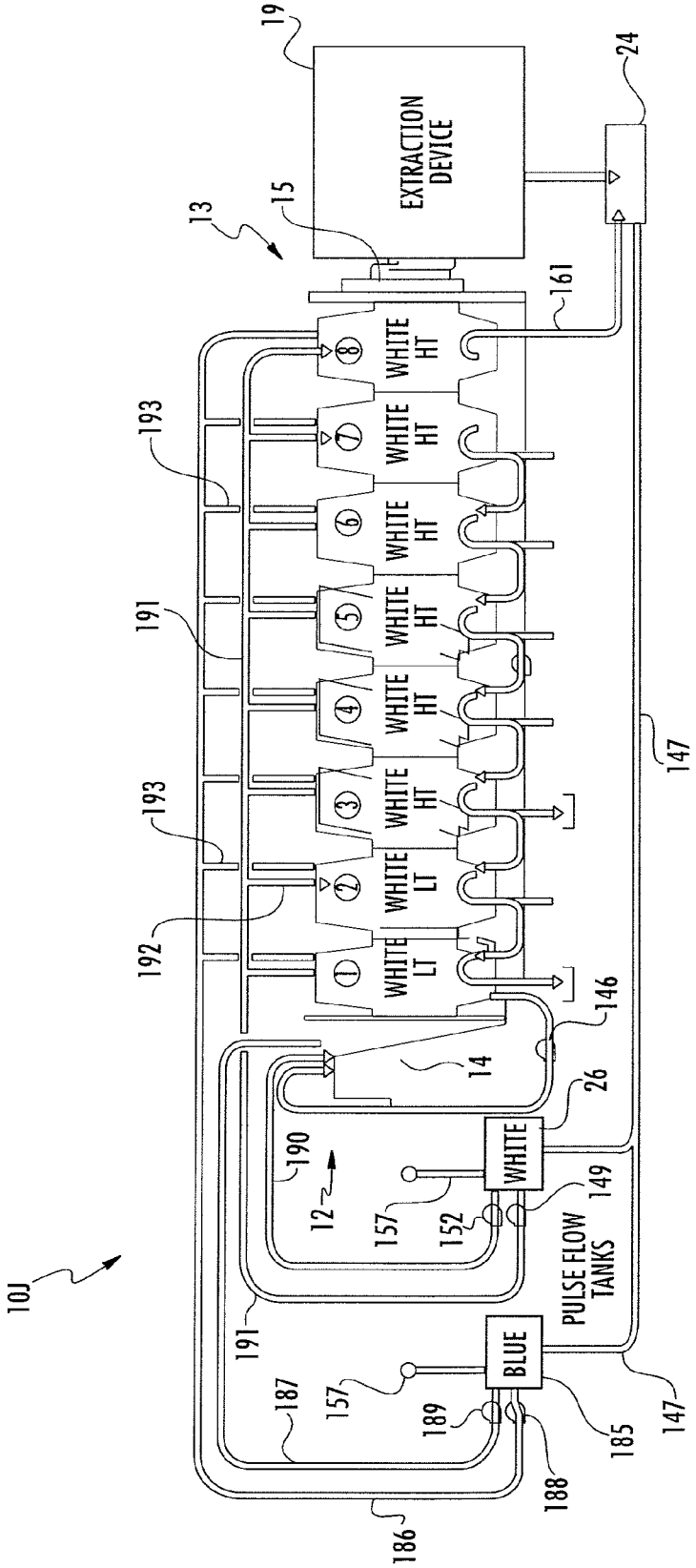
EXTRACTION DEVICE
19
24
13
15
161
WHITE HT
WHITE LT
193
191
192
147
146
14
26
190
12
157
152
WHITE
149
PULSE FLOW TANKS
BLUE
187
189
185
188
186
10J

FIG. 22

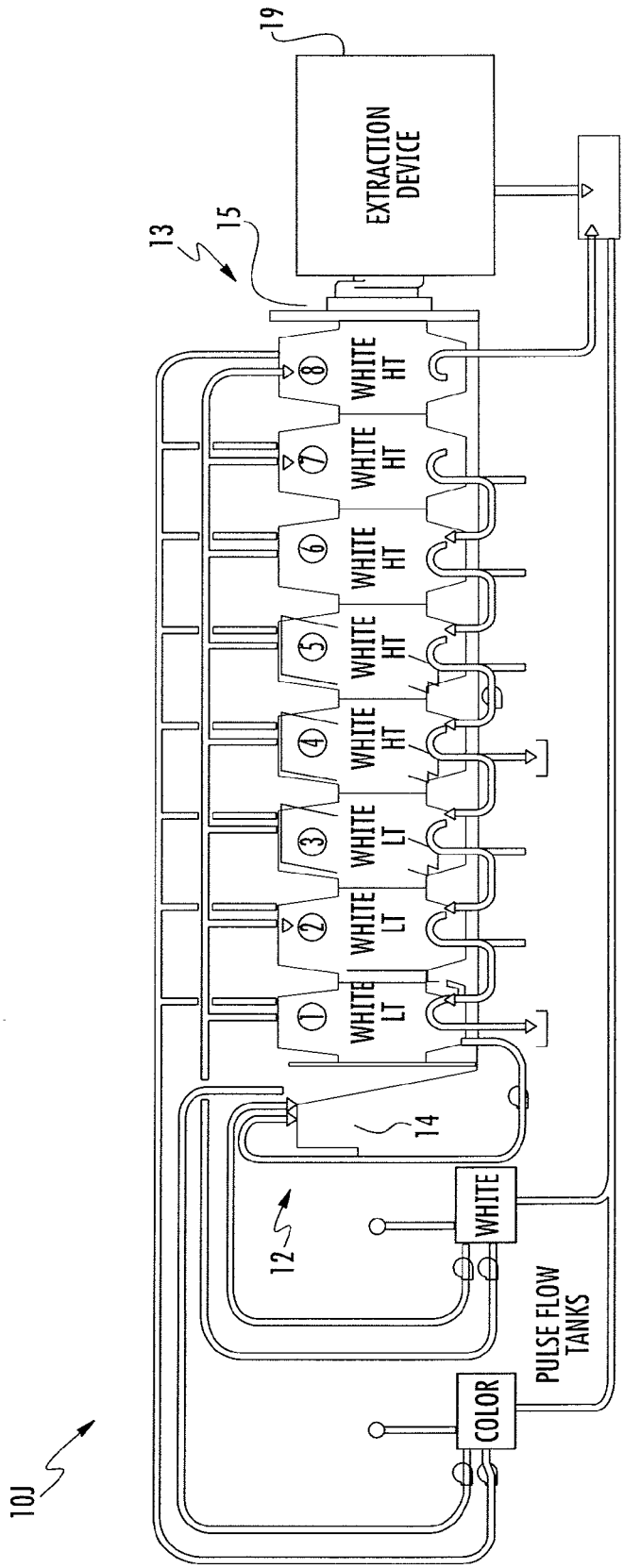
19
EXTRACTION DEVICE
13
15
WHITE HT
WHITE HT
WHITE HT
WHITE HT
WHITE HT
WHITE LT
WHITE LT
WHITE LT
14
12
WHITE
COLOR
PULSE FLOW TANKS
10J

FIG. 23

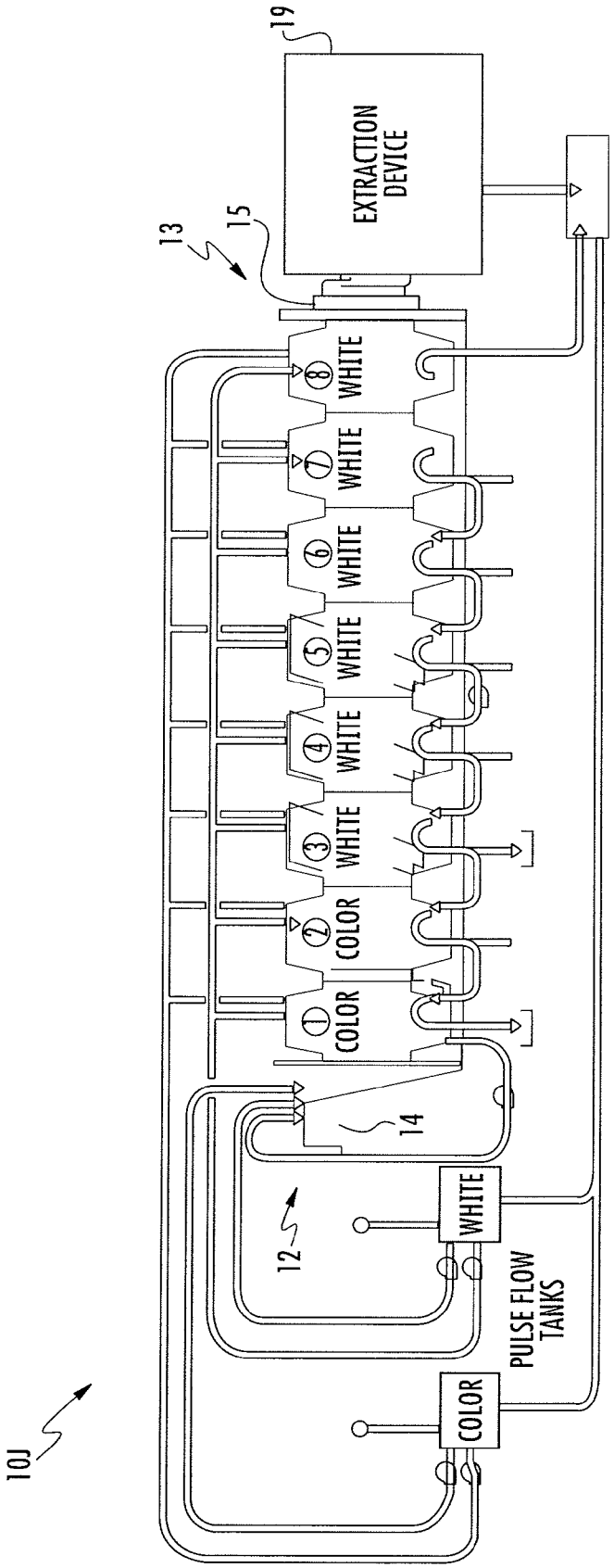
19
EXTRACTION DEVICE
13
15
8 WHITE
7 WHITE
6 WHITE
5 WHITE
4 WHITE
3 WHITE
2 COLOR
1 COLOR
14
12
WHITE
COLOR
PULSE FLOW TANKS
10J

FIG. 24

CONTINUOUS BATCH TUNNEL WASHER AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a nonprovisional patent application of U.S. Provisional Patent Application Ser. No. 61/691,140, filed 20 Aug. 2012; U.S. Provisional Patent Application Ser. No. 61/765,484, filed 15 Feb. 2013; and U.S. Provisional Patent Application Ser. No. 61/818,882, filed 2 May 2013, each of which is hereby incorporated herein by reference.

Priority of U.S. Provisional Patent Application Ser. No. 61/691,140, filed 20 Aug. 2012; U.S. Provisional Patent Application Ser. No. 61/765,484, filed 15 Feb. 2013; and U.S. Provisional Patent Application Ser. No. 61/818,882, filed 2 May 2013, each of which is hereby incorporated herein by reference, is hereby claimed.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to continuous batch washers or tunnel washers. More particularly, the present invention relates to an improved method of washing textiles or fabric articles (e.g., clothing, linen) in a continuous batch multiple module tunnel washer wherein the textiles are moved sequentially from one module to the next module and wherein one or more modules have conductivity sensors that monitor water conductivity. Water is selectively transferred in order to maintain water conductivity to within a pre-selected acceptable range which aids in proper ironing of textile articles.

2. General Background of the Invention

Currently, washing in a commercial environment is conducted with a continuous batch tunnel washer. Such continuous batch tunnel washers are known (e.g., U.S. Pat. No. 5,454,237) and are commercially available (www.milnor-.com). Continuous batch washers have multiple sectors, zones, stages, or modules including for example, pre-wash, wash, rinse and finishing zone.

Commercial continuous batch washing machines in some cases utilize a constant counterflow of liquor. Such machines are followed by a centrifugal extractor or mechanical press for removing most of the liquor from the goods before the goods are dried. Some machines carry the liquor with the goods throughout the particular zone or zones.

When a counterflow is used in the prior art, there is counterflow during the entire time that the fabric articles or textiles are in the main wash module zone. This practice dilutes the washing chemical and reduces its effectiveness.

A final rinse with a continuous batch washer has been performed using a centrifugal extractor or mechanical press. A problem occurs in prior art systems when the water that is used for the press has a conductivity that exceeds a preset limit (for example, about 1,000 microsiemens) above incoming fresh water. In such a case, the press water with excessive conductivity can cause the linen to stick to ironing implements such as an ironer roll that rests upon a chest. Without proper rinsing with water having proper conductivity, the linen can stick on the chest part of the ironer roll.

Patents have issued that are directed to batch washers or tunnel washers. The following table provides examples of such patented tunnel washers, each listed patent of the table being hereby incorporated herein by reference.

TABLE

PAT. NO.	TITLE	ISSUE DATE MM-DD-YYYY
4,236,393	Continuous tunnel batch washer	12-02-1980
4,485,509	Continuous batch type washing machine and method for operating same	12-04-1984
4,522,046	Continuous batch laundry system	06-11-1985
5,211,039	Continuous batch type washing machine	05-18-1993
5,454,237	Continuous batch type washing machine	10-03-1995

BRIEF SUMMARY OF THE INVENTION

The present invention provides an improved method of washing fabric articles in a continuous batch tunnel washer. The method includes providing a continuous batch tunnel washer having an interior, an intake, a discharge, a plurality of modules, and a volume of liquid.

The present invention provides an improved method and apparatus for washing or laundering items in a continuous batch or tunnel washer. The present invention provides an improved method and apparatus for laundering articles in a continuous batch or tunnel washer that also employs an extractor such as a centrifuge or press, solving a problem that results in a sticking or adherence of the linen to the chest of an ironer roll because of improper conductivity of the water.

The present invention provides a tunnel washer or continuous batch washer that employs conductivity sensors located in one or more positions such as for example the press tank, incoming fresh water stream, and "pulse flow" tank.

In one embodiment, the maximum conductivity range of the press water is compared to incoming fresh water.

In one embodiment, the maximum conductivity range of the pulse flow tank water is compared to incoming fresh water.

In one embodiment, if the press water conductivity exceeds a preset limit (for example, 1,000 microsiemens above incoming fresh water), the fresh water then flows from one of the modules (for example, the last module) into the press tank such as for example during a "pulse flow" or higher velocity flow time of a transfer cycle.

In this manner, the conductivity of the press water will be adjusted (e.g., lowered) back to a pre-programmed, pre-selected acceptable range. The present invention thus corrects a problem before the pulse flow tank can reach a conductivity that is beyond a desired or selected range.

With the present invention, if an upset condition occurs in the pulse flow tank (i.e., exceeding its programmed range), a drain valve can be used to discharge water flow directly into the tank to correct the upset condition.

An alternate method provides an "empty pocket" that is inserted into a module such as module **1** (e.g., first module) with the drain open. The "empty pocket" is simply a module that is purposefully not filled with fabric articles (e.g. linen, clothing, or the like). Water from a pump counter flows from one of the later modules (e.g. module **8**) to sewer through the first module drain. Upon the next transfer of fabric articles to the next downstream module, the "empty pocket" advances to second module, then to the third module and so forth. For an

eight module washer, the empty pocket will initially be the first module or module **1**. The empty pocket then moves to the second module or module **2**. The empty pocket then moves in sequence to module three, then module **4**, then module **5** then module **6** then module **7** and finally module **8** is the empty pocket. In each module that is the empty pocket, the water from the pump is diverted to sewer. This method recovers the over conductivity measured in the press water faster because the free water that has too high a conductivity in the pulse flow zone is cleared faster by diverting the pulse flow water into the advancing "empty pocket" that has no clothing, linen, or fabric articles. This alternate method minimizes the time out of range conductivity by about 40 to 50% (one method requires 6 to 10 transfers to clear the conductivity error whereas the alternate method only requires 2 to 6 transfers).

The present invention includes a method of washing fabric articles in a continuous batch tunnel washer. The method can provide a continuous batch tunnel washer having an interior, an intake, a discharge, a plurality of modules, and a volume of liquid. The fabric articles can be moved from the intake to the modules and then to the discharge in sequence. A washing chemical can be added to the volume of liquid. The fabric articles can be discharged after to an extractor that removes excess water from the fabric articles, discharging said excess water to a press water tank. An ironer can be provided that receives fabric articles. Conductivity can be monitored of fluid in at least one of the modules. Conductivity can be monitored of fluid in the press water tank. Water can be added to one or more modules if the conductivity of water in the press water tank exceeds a threshold value so that the fabric articles to be ironed hold only water with a conductivity that is within an acceptable conductivity range.

In one embodiment, the extractor can be a press.

In one embodiment, the extractor can be a centrifuge.

In one embodiment, the threshold value can be about 1000 microSiemens per centimeter.

In one embodiment, the threshold value can be between about 100 micro Siemens and 1000 micro Siemens above the conductivity value of the incoming or available water or source water.

In one embodiment, the invention further includes the step of after a selected time period, counter flowing a rinsing liquid along a flow path that can be generally opposite the direction of travel of the fabric articles.

In one embodiment, the water added can be a fresh influent water stream.

The present invention includes a method of washing and drying fabric articles in a continuous batch tunnel washer and ironer. The method can provide a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior. The fabric articles can be moved from the intake to the discharge. A washing chemical can be added to one or more of the modules. The fabric articles can be discharged. A source of fresh, make-up water can be provided. Conductivity can be monitored of fluid in at least one of the modules. Conductivity can be monitored of fluid in the discharged fabric articles. Make-up water can be added to one or more modules if the conductivity of water in the discharged fabric articles exceeds a threshold value.

In one embodiment, the present invention further includes the step of extracting water from the fabric articles, the extracted water can be monitored for said conductivity to provide the value of conductivity for the discharged fabric articles.

In one embodiment, the threshold value is at least about 100 micro Siemens above the conductivity value of the incoming or available water or source water.

In one embodiment, the present invention further includes maintaining the conductivity of the water in the discharged fabric articles to a value of between about between about 100 micro Siemens and about 1000 micro Siemens above the conductivity value of the incoming or available water or source water.

The present invention includes a method of washing fabric articles in a continuous batch tunnel washer. The method provides a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and wherein one of the modules is an empty pocket that is drained of water. Fabric articles can be moved from the intake to the discharge and through the modules in sequence. A washing chemical can be added to one or more of the modules. The fabric articles can be rinsed by counter flowing liquid in the washer interior along a flow path that is generally opposite the direction of travel of the fabric articles, wherein one of the modules defines and empty pocket that is drained of water during this step, wherein one of the modules can be an empty pocket that is drained of fluid during such rinsing with counterflowing liquid. Wherein one of the modules can be an empty pocket that is drained of fluid.

In one embodiment, one of the modules can be an empty pocket that is drained of fluid and that does not have any fabric articles such as linens.

In one embodiment, the invention further comprises extracting excess fluid from the fabric articles.

In one embodiment, the empty pocket is moved from an upstream location to a downstream location. For example, for an eight module washer, the empty pocket moves from the first module at the intake end of the washer and then to modules **2**, **3**, **4**, **5**, **6**, **7**, **8** in sequence.

In one embodiment, the empty pocket separates white fabric articles from non-white fabric articles.

In one embodiment, the empty pocket separates white fabric articles from colored fabric articles.

In one embodiment, the empty pocket separates higher temperature modules from lower temperature modules.

The present invention includes a method of laundering fabric articles in a continuous batch tunnel washer. The method can provide a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior. Fabric articles can be moved in a first direction of travel from the intake to the discharge. The fabric articles can be washed with a chemical bath in one or more of said modules. The fabric articles can then be rinsed. An empty pocket can be provided in one or more of said modules that is drained of fluid. Wherein the empty pocket is moved in a direction from the intake towards the discharge. Liquid can be counterflowed in the washer during the step of rinsing the fabric.

Another embodiment of the present invention includes a method of washing fabric articles in a continuous batch tunnel washer, comprising the steps of: a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and wherein one of the modules is an empty pocket that is drained of water, said modules including a first module next to the intake and a final module next to the discharge; b) moving the fabric articles from the intake to the discharge and through the modules in a sequence beginning with the first module and ending with the final module; c) adding a washing chemical to one or more of the modules; d) rinsing the fabric articles by counter flowing liquid in the washer interior along a flow path that is generally opposite the direction of travel of the fabric articles in steps "b" and "c"; e) wherein one of the modules defines an empty pocket module that is drained of fluid during

step "d"; and f) wherein the modules that are not empty pocket modules contain both fabric articles and fluid.

In another embodiment, the method of the present invention further comprises extracting excess fluid from the fabric articles after step "e". In one embodiment, the empty pocket is moved from an upstream location to a downstream location.

In another embodiment of the method of the present invention, the empty pocket separates white fabric articles from non-white fabric articles, and in another embodiment, the empty pocket separates white fabric articles from colored fabric articles. In another embodiment, the empty pocket separates higher temperature modules from lower temperature modules.

In another embodiment of the method of the present invention, there are multiple different counterflow streams in step "d". In one embodiment, one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses the non-white fabric articles. In one embodiment, one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses colored articles. In another embodiment one counterflow stream rinses higher temperature modules and another counterflow stream rinses lower temperature modules.

Another embodiment of the present invention includes a method of laundering fabric articles in a continuous batch tunnel washer, comprising the steps of: a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior; b) moving the fabric articles and fluid in a first direction of travel from the intake to the discharge; c) washing the fabric articles with a chemical bath in one or more of said modules; d) rinsing the fabric articles after step "c"; e) providing an empty pocket in one or more of said modules that is drained of fluid; f) wherein the empty pocket is moved from one module to the next module in sequence, and in a direction from the intake towards the discharge; and g) counterflowing liquid in the washer during step "d".

Another embodiment of the present invention includes a method of washing fabric articles in a continuous batch tunnel washer, comprising the steps of: a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and wherein one of the modules is an empty pocket that is drained of water; b) moving the fabric articles and a volume of liquid from the intake to the discharge and through the modules in sequence; c) adding a washing chemical to one or more of the modules; d) rinsing the fabric articles by counter flowing liquid in the washer interior along a flow path that is generally opposite the direction of travel of the fabric articles in steps "b" and "c"; and e) wherein one of the modules defines an empty pocket module that is drained of liquid during step "d".

In another embodiment of the method of the present invention, the method further comprises extracting excess fluid from the fabric articles after step "e".

In another embodiment of the method of the present invention, the empty pocket is moved from an initial upstream location to downstream modules that are downstream of said initial upstream location.

Another embodiment of the present invention includes a method of laundering fabric articles in a continuous batch tunnel washer, comprising the steps of: a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and including at least one intake module and at least one final module; b) moving the fabric articles in a first direction of travel from the intake to the discharge; c) washing the fabric articles with a chemical bath in one or more of said modules; d) rinsing the fabric articles after step "c"; e) providing an empty pocket in one or more of said modules that is drained of fluid; f) wherein the empty pocket is moved one module at a time starting at the intake module and ending at the final module, and in a direction from the intake towards the discharge; and g) counterflowing liquid in the washer during step "d".

In another embodiment of the method of the present invention, the empty pocket separates white fabric articles from non-white fabric articles, and in another embodiment the empty pocket separates white fabric articles from colored fabric articles. In one embodiment the empty pocket separates higher temperature modules from lower temperature modules.

In another embodiment of the method of the present invention, there are multiple different counterflow streams in step "g". In one embodiment one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses non-white fabric articles. In another embodiment, one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses colored fabric articles. In another embodiment of the method of the present invention one counterflow stream rinses higher temperature modules and another counterflow stream rinses lower temperature modules.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For a further understanding of the nature, objects, and advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

FIG. **1** is comprised of half FIGS. **1**A-**1**B that connect at match lines A-A, providing a schematic diagram showing a preferred embodiment of the apparatus of the present invention;

FIG. **2** is comprised of half FIGS. **2**A-**2**B that connect at match lines B-B providing a schematic diagram showing a preferred embodiment of the apparatus of the present invention;

FIG. **3** is a fragmentary view of a preferred embodiment of the apparatus of the present invention illustrating the ironer rolls for demonstrating that without proper rinsing the linen can stick to the chest portion of the ironer roll;

FIG. **4** is comprised of half FIGS. **4**A-**4**B that connect at match lines C-C, providing a diagram of an alternate embodiment of the apparatus of the present invention;

FIG. **5** is a fragmentary view of the alternate embodiment of the apparatus of the present invention;

FIG. **6** is a diagram of an alternate embodiment of the apparatus of the present invention showing a five module tunnel washer for use in the hospitality industry and with chlorine bleach;

FIG. **7** is a diagram of an alternate embodiment of the apparatus of the present invention showing a five module tunnel washer for use in the hospitality industry and with hydrogen peroxide;

FIG. **8** is a diagram of an alternate embodiment of the apparatus of the present invention showing a five module tunnel washer for use in the hospitality industry and with sanitizing sour;

FIG. **9** is a diagram of an alternate embodiment of the apparatus of the present invention showing a seven module tunnel washer for use in the hospitality industry and with chlorine bleach;

FIG. **10** is a diagram of an alternate embodiment of the apparatus of the present invention showing a seven module tunnel washer for use in the hospitality industry and with hydrogen peroxide;

FIG. **11** is a diagram of an alternate embodiment of the apparatus of the present invention showing a seven module tunnel washer for use in the hospitality industry and with sanitizing sour;

FIG. **12** is a diagram of an alternate embodiment of the apparatus of the present invention showing an eight module tunnel washer for use in the hospitality industry and with chlorine bleach;

FIG. **13** is a diagram of an alternate embodiment of the apparatus of the present invention showing an eight module tunnel washer for use in the hospitality industry and with hydrogen peroxide;

FIG. **14** is a diagram of an alternate embodiment of the apparatus of the present invention showing an eight module tunnel washer for use in the hospitality industry and with sanitizing sour;

FIG. **15** is a diagram of an alternate embodiment of the apparatus of the present invention showing a ten module tunnel washer for use in the hospitality industry and with chlorine bleach;

FIG. **16** is a diagram of an alternate embodiment of the apparatus of the present invention showing a ten module tunnel washer for use in the hospitality industry and with sanitizing sour;

FIG. **17** is a diagram of an alternate embodiment of the apparatus of the present invention showing a twelve module tunnel washer for use in the hospitality industry and with chlorine bleach;

FIG. **18** is a diagram of an alternate embodiment of the apparatus of the present invention showing a twelve module tunnel washer for use in the hospitality industry and with hydrogen peroxide;

FIG. **19** is a diagram of an alternate embodiment of the apparatus of the present invention showing a twelve module tunnel washer for use in the hospitality industry and with sanitizing sour;

FIG. **20** is a schematic diagram of a preferred embodiment of the apparatus of the present invention showing a twelve module tunnel washer with alternate pulse flow and long distance incompatibility avoidance for incompatible batches;

FIG. **21** is a schematic diagram of an alternate embodiment of the apparatus of the present invention having alternate pulse flow and long distance incompatibility avoidance wherein white textile articles follow colored or non-white textile articles;

FIG. **22** is a schematic diagram of a preferred embodiment of the apparatus of the present invention showing an eight module tunnel washer with alternate pulse flow and wherein low temperature white fabric articles follow high temperature white fabric articles;

FIG. **23** is a schematic diagram of a preferred embodiment of the apparatus of the present invention showing an eight module tunnel washer with alternate pulse flow and wherein low temperature white fabric articles follow high temperature white fabric articles; and

FIG. **24** is a schematic diagram of a preferred embodiment of the apparatus of the present invention showing an eight module tunnel washer with alternate pulse flow and wherein color fabric articles follow white fabric articles.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. **1-2** show a preferred embodiment of the apparatus of the present invention designated generally by **10**A in FIGS. **1** and **2**. It should be understood that FIG. **1** includes half FIGS. **1**A and **1**B that assemble at match lines A-A. FIG. **2** includes half FIGS. **2**A and **2**B that assemble at match lines B-B. In FIG. **1** there can be seen a textile washing apparatus **10**A which employs a tunnel washer **11** having an inlet end portion **12** and an outlet end portion **13**. The inlet end portion **12** has a hopper **14** that enables the tunnel washer **11** to accept soiled linen or fabric articles **25** as indicated generally by arrow **16** in FIG. **2**. A discharge **15** from tunnel washer **11** enables laundered articles such as linen to be transferred from tunnel washer **11** to an extractor the removes water such as a press **19**. From the press or extractor **19**, the laundered articles can be moved using a shuttle **20** to a dryer **21** and then via transport **22** to a finishing station **23** (see FIG. **2**). The tunnel washer **11** provides a plurality of modules or stations **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9**, **10**. Fabric articles to be cleaned are moved generally in the direction of arrows **17**, **18** in FIG. **2**. Counterflow flow lines **193** are provided for counterflowing fluid from one module (e.g. module **4**) to the previous module (module **3**). Such counterflow flow lines **193** can be provided for each embodiment of FIGS. **1-24** to counterflow fluid from any downstream module to an upstream module or in a direction opposite to arrows **17**, **18**. In FIG. **1**, there is provided an extractor reuse tank **24** and a "pulse flow" tank **26**. "Pulse flow" tank **26** provides a supply of water to pumps **38**, **69**. These pumps then transmit water at a high flow rate (e.g., between 75 (283) and 250 (946.4) gallons (liter) per minute) to a selected module or modules.

A plurality of conductivity sensors are provided as part of the apparatus **10**A. In FIG. **1**, a conductivity sensor **27** is provided in the extractor reuse tank **24**. Another conductivity sensor **28** is provided in the pulse flow tank **26**. A third conductivity sensor **29** is provided in the influent flow line **30** to monitor the conductivity of fresh water that is flowing through the influent flow line **30** (from a selected source). The source of fresh water in flow line **30** can include a cold source **79** of fresh water as well as a hot or tempered source **80** of fresh water. The present invention monitors conductivity of water that is contained in the modules **1-10** and adjusts by adding fresh water or make up water in order to maintain the conductivity in modules **1-10** within a selected or desired range (i.e. between about 100 micro Siemens (minimum value) and a maximum value of about 1000 micro Siemens above the conductivity value of the incoming or available water or source water).

Because the fluid that is discharged from modules **9** and **10** through valves **63** and **64** enters extractor reuse tank **24**, the conductivity sensor **27** in tank **24** monitors the conductivity of the tunnel washer modules **9** and **10**. Valve **63** feeds flow line **65**. A tee fitting **67** joins valve **64** with lines **65** and **66** as shown in FIG. **1**. The line **66** feeds water to the extractor reuse tank **24** where conductivity is measured by sensor **27**.

Pump **58** discharges water from extractor reuse tank **24** and transmits that water via line **68** to the pulse flow tank **26**. Valves can be provided at **60**, **34** in flow line **68**. A drain can be provided in the form of valve **61** as shown in FIG. **1** for discharging directly to a sewer **62** or other suitable drain. A valve **59** is provided for discharging water directly from extractor reuse tank **24** if desired.

Water in pulse flow tank **26** is monitored for conductivity using conductivity sensor **28**. The conductivity of water in tank **26** can be monitored and adjusted by introducing water from an outside source **79** and/or **80** through flow line **30** and

meter **31**. Conductivity sensor **29** monitors the conductivity of water in flow line **30** before it reaches pulse flow tank **26**. Additionally, the water in tank **26** is also monitored for conductivity by sensor **28**. Flow meter **31** and valve **32** can be provided in flow line **30**. Water can be discharged from tank **26** to sewer **43** by opening valve **33**. Water can also be discharged from tank **26** through flow line **37** using pump **38**. Water exiting tank **26** through flow line **37** can be injected into either module **8** or **9** as shown in FIG. **1** using valves **39**, **41** or **42**.

A plurality of flow meters can be provided in the various flow lines. The flow line **37** can be equipped with a flow meter **40**. A flow meter **31** is provided in the influent flow line **30**. A flow meter **47** is provided in the flow line **44**.

The influent flow line **30** provides a valve **32**. The influent flow line **30** provides make up water as needed for the pulse flow tank **26**. The module **10** can be a standing bath. The module **9** can be a standing bath or wash module.

Flow line **35** and pump **69** in FIG. **1** enable water to be transferred from pulse flow tank **26** to module **10**. Flow line **35** can be provided with valve **36**. Flow line **44** transfers water from module **5** to module **4**. Flow line **44** can be provided with pump **45**, valve **46** and flow meter **47**. Flow line **48** enables water to be transferred from module **1** through pump **49** into hopper **14**. In this fashion, soiled laundry or other textile articles added to hopper **14** are immediately wetted with a fast moving stream of water while entering module **1**. This function allows the washing process to start in module **1** whereas previous practice module **1** was used only to wet the linen. Flow line **50** enables fresh water to be added directly to module **10**. Influent flow line **50** can be provided with flow meter **51** and tee fitting **52**. Tee fitting **52** enables fresh water to be transferred to either flow line **53** or **54**, each equipped with a valve **55** or **56** as shown. In this fashion, fresh water can be added to either module **9** or **10** in order to adjust conductivity of the water in those modules **9** and **10** to a selected range. A tee fitting **71** can be provided in flow line **35** for adding water directly to hopper **14**. The tee fitting **71** enables water to enter hopper **14** through flow line **72** which is equipped with valve **57** and flow meter **70**.

FIG. **3** shows an ironer that is designated generally by the numeral **73**. Ironer **73** can include multiple rolls or rollers **75**, each supported upon a chest **74**. In the prior art, linen sheets or other fabric articles **25** could stick to the chest **74** without proper rinsing. Further, if the conductivity of the water in the linen sheets or fabric articles **25** was outside a selected range, the linen could stick to any one of the chests **74**.

With the present invention, the linen sheets or fabric articles **25** (which are indicated schematically by the dotted line **77**) in FIG. **3** are less likely to stick to the chest **74** because conductivity of the water is monitored and held within a selected range of between about 100 micro Siemens (minimum value) and a maximum value of about 1000 micro Siemens above the conductivity value of the incoming or available water or source water. In FIG. **3**, the arrow **76** schematically illustrates the intake of linen sheets whereas the arrow **78** indicates schematically the discharge of linen sheets after ironing. The ironer **73** shown in FIG. **3** can be part of the finishing station **23** of FIG. **2**.

FIGS. **4-5** show an alternate embodiment of the apparatus of the present invention designated as **10**B. It should be understood that FIG. **4** includes half FIGS. **4**A-**4**B that assemble at match lines C-C. As with the embodiment of FIGS. **1-3**, textile washing apparatus **10**B provides a tunnel washer **11** having a plurality of modules or stations (e.g., between 1 and 32 stations or modules) **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9**, **10**, inlet end portion **12**, outlet end portion **13** and discharge **15**. The apparatus **10**B can employ the press/extractor **19**, shuttle **20**, dryer **21**, transport **22** and finishing station **23** of FIG. **2** and the ironer **73** arrangement of FIG. **3**.

Fabric or textile articles **25** to be cleaned are added to hopper **14** at inlet end portion **12**. Fabric or textile articles **25** to be cleaned are moved generally in the direction of arrows **17**, **18** in FIG. **4**. In FIGS. **4-5**, an "empty pocket" is provided in a selected module **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9** or **10**. For example, the empty pocket can initially be module **1**, the first module that is next to the inlet end portion **12**. The empty pocket then moves in sequence to the second module **2**, then to the third module **3**, then to modules **4**, **5**, **6**, **7**, **8**, **9** and finally module **10**. This "empty pocket" module typically has no linen. Notice in FIG. **5** that the empty pocket with no linen is module **3**. The empty pocket module is created by allowing a transfer of linen from one module to the next for all modules other than the empty pocket module.

For the empty pocket module, no linen is put into the first empty pocket module **1**. On the next transfer of linen from each module to the next module, the empty pocket module is now module **2**. It is possible to have more than one empty pocket module by means of programming the controller. This "empty pocket" module arrangement minimizes the time out of range conductivity by about forty to fifty percent (40-50%). With the alternate method and apparatus of FIGS. **4-5**, as few as two to six transfers are needed to clear a conductivity error compared to between ten and twenty transfers required for a comparable tunnel washer that does not employ this "empty pocket" module arrangement of FIGS. **4-5**.

As with the preferred embodiment of FIGS. **1-3**, textile washing apparatus **10**B can employ conductivity sensors **27**, **28**, **29**. Many of the flow lines, valves, fittings and components of FIG. **1** can be seen in FIG. **4**. In FIG. **5**, water header **121** is supplied with water from tank **26** with an alternate pump **122**. Module **2** receives water through fill valve **124** during a "pulse flow" portion of the cycle. The overall cycle sequence is comprised of three functions: (1) standing bath, which can be about 75% of the cycle; (2) "pulse flow" (high speed or high flow rate rinsing), which can be about 24% of the cycle; and (3) transfer (movement of the linen from one module to the next module, e.g., module **1** to module **2**), which can be about 1% of the cycle.

"Pulse flow" is a high velocity rinsing step. Flow line **121** is a simplified representation of the headers shown in FIG. **4**A. Pump **101** (the alternative pulse flow pump) supplies water to header **102** or header **104**. In FIG. **5**, flow line **121** represents either of these headers **102**, **104**. The empty pocket separates heavily lint fabric articles (e.g., bar towels) from different fabric articles (e.g., table linen). Although valve **124** remains open during the pulse flow portion of the cycle, no water flows because the alternate pulse flow pump **122** is turned off. Fill valves **123**, **125** and **126** are closed. Water counterflows from module **4** to module **3** via a counterflow flow line **193** and through open valve **134**. However, this water goes immediately to sewer **128** via flow line **127** (see arrow **140**, FIG. **5**) and open drain valve **130**. Module **3** (the empty pocket module) remains empty of water. The valve conditions shown in FIG. **5** accompany an empty pocket of module **3**. This valve condition moves with the "empty pocket" as it moves from one module to the next module through the tunnel washer **11** in the direction of arrows **17**, **18**. In the method and apparatus of FIGS. **4** and **5**, the "empty pocket" is first placed in module **1**, then moves to module **2**, then **3**, then to each subsequent module in sequence: **4**, **5**, **6**, **7**, **8**, **9** until the empty pocket reaches the last module **10**. In this case where module **10** is the empty pocket, the controller will

signal the receiving apparatus, such as a press or an extractor, that there is no linen in the press or extractor so that it does not cycle.

Counterflow in washer **11** is controlled by the counterflow valves **132**, **133**, **134**, **135**. Counterflow is permitted when the valve **133** for flow from module **3** to the previous module **2** is open and the valve **136** for flow to the sewer **128** is closed. Counterflow is prevented when the valve states are opposite. Although counterflow would be possible between module **3** and module **2** in FIG. **5**, there is no water available for counterflow as long as drain valve **130** remains open. Any chemical inlets or dispensers **120** on module **3** remain closed during the empty pocket portion of the cycle.

In FIG. **4**, flow line **81** connects with Tee-fitting **82** to flow line **102**. Line **81** provides valve **83** and flow meter **84**. Line **102** provides valve **85**. As can be seen in FIG. **4**, line **102** discharges into module **9**. Tee-fittings are provided at **86**, **87** and flow line **102**. Line **88** connects with flow line **102** at Tee-fitting **86**. Line **88** provides valve **89** and discharges into module **7**. Line **90** joins line **102** at Tee-fitting **87**. Line **90** provides valve **91** and discharges into module **8**. Flow line **92** has flow meter **93** and valve **94**. Tee-fitting **95** joins flow line **92** with flow line **104**. Line **92** has valve **96**, Tee-fitting **97** and flow meter **99**. Line **103** joins line **92** at Tee-fitting **97**. Below Tee-fitting **97**, line **92** is designated as **100** and connects with pump **101** that communicates with tank **26**. Flow line **81** has valve **98** and is designated as line **103** below Tee-fitting **102**, joining with line **100** at fitting **97**. Flow line **104** joins to line **92** at Tee-fitting **95**. Tee-fittings **105**, **106**, **107** and **108** are provided in flow line **104**. Line **109** connects to Tee-fitting **105**. Line **110** connects to Tee-fitting **106**. Line **111** connects to line **104** at Tee-fitting **107**. Line **112** connects to line **102** at Tee-fitting **108**. Flow line **109** has valve **114**. Flow line **110** has valve **115**. Flow line **111** has valve **116**. Flow line **112** has valve **117**. Flow line **104** has valve **118**.

FIGS. **6-24** show variations of the washing apparatus **10**A, **10**B of FIGS. **1-5**. FIG. **6** shows a five module washing apparatus, designated generally by the numeral **10**C. Washing apparatus **10**C can be a tunnel washer having modules **1**, **2**, **3**, **4**, **5** wherein modules **1**, **2**, **3**, **4** can be dual use modules that perform both wash and rinse functions. Module **5** is a finish module. Washing apparatus **10**C has an inlet end portion with hopper **14** for intake of laundry or textile articles or linens and a discharge end portion that discharges fabric articles, linens, laundry to an extraction device **19** (e.g., press or centrifuge). As with the embodiments of FIGS. **1-5**, FIGS. **6-24** can provide counterflow flow lines for counterflowing fluid from a downstream module (e.g., module **4**) to an upstream module (e.g., module **3**).

FIG. **6** is an example of an apparatus having particular utility for the hospitality sector of business. Line **141** is a counterflow line from module **4** to module **3**. Line **142** is a counterflow line from module **3** to module **2**. Line **143** is a counterflow line from module **2** to module **1**. Lines **144**, **145** and valved drain lines to sewer **128**. Line **146** is a valved recirculation line to hopper **14**. As with FIGS. **1-5**, FIG. **6** employs tanks **24**, **26**. Flow line **161** drains module **5** to tank **24**. Line **147** transmits fluid from tank **24** to tank **26**. Flow line **148** has pump **149** and transmits fluid from tank **26** to module **5** and/or hopper **14** via branch line **150**. Line **151** and pump **152** transmit fluid from tank **26** to module **4**. Alkali detergent at **153** is shown for addition to module **1**. Chlorine bleach is shown at **154** for addition to module **2**. Antichlor sour solution is shown at **155** for addition to module **5**.

For exemplary parameters of FIG. **6**, total time is 17.5 minutes. Transfer time of fabric articles, linens, laundry from one module to the next module (e.g., module **1** to module **2** or module **2** to module **3**, etc.) is 180 minutes. Batches of laundry, linens, fabric articles per time is about 17 batches per hour. Water consumption is 0.3 to 0.4 gallons per pound of laundry (2.5 to 3.3 liters per kilogram of laundry). Average pulse flow water quantity is 105 gallons (or 398 liters) per batch of laundry. In FIG. **7**, washer **10**C replaces chlorine bleach at **154** with hydrogen peroxide at **156**. Water can be added to tank **26** via source **157** and valved flow line **158**. In FIG. **8**, sanitizing sour at **159** is added to module **4**. In FIG. **8**, chlorine bleach **154** and hydrogen peroxide **156** are not present.

FIGS. **9-11** show an arrangement similar to FIGS. **6-8** but for a seven module tunnel washer apparatus **10**D wherein alkali detergent **153** is added to modules **1**, **2** with chlorine bleach **154** is added to module **3** and antichlor sour **155** to module **7**. In FIG. **10**, hydrogen peroxide **156** replaces chlorine bleach **154**. In FIG. **11**, sanitizer sour **160** is added to module **4** and sour solution **161** to module **7** while chlorine bleach and hydrogen peroxide are not present. In FIGS. **9-11**, counterflow lines are provided as with FIGS. **1-8**. One of the counterflow flow lines can be provided with pump **162**. Pump **162** can be in the counterflow flow line that transmits fluid from module **5** to module **4**. In FIGS. **9-11**, exemplary parameters are 14.6 minutes total time. Transfer time is 129 seconds. Batches per time equals 29 per hour. Water consumption is 0.3 to 0.4 gallons per pound of fabric articles (e.g., linens) or between 2.5-3.3 liters per kilogram. Pulse flow water liquor ratio is about 0.7 gallons per pound or 5.8 liters per kilogram. Average pulse flow water per batch is 105 gallons (397.5 liters).

FIGS. **12-14** show a washing apparatus similar to FIGS. **6-8**, but for an eight module washer **10**E. In FIGS. **12-14**, alkali detergent **153** is added to modules **1**, **2**. Chlorine bleach **154** is added to modules **3**, **4** and antichlor sour solution **155** to module **8**. In FIG. **13**, hydrogen peroxide **156** replaces the chlorine bleach **154** of FIG. **12**. In FIG. **14**, neither chlorine bleach **154** nor hydrogen peroxide **156** are used. Instead, sanitizing sour **159** is added to module **5** and sour solution **160** is added to module **8**. In FIGS. **12-14**, the counterflow lines are provided as with FIGS. **1-11**. One of the counterflow lines can be provided with pump **163**. Pump **163** can be in the counterflow line that transmits fluid from module **5** to module **4**.

FIGS. **15-16** show a ten module washing apparatus **10**F wherein pump **164** is in a counterflow line that transmits fluid from module **6** to module **5**.

FIGS. **17-19** show a twelve module washing apparatus **10**G wherein pump **165** is in a counterflow line from module **8** to module **7**. Pump **166** is in a counterflow line from module **4** to module **3**.

FIG. **20** shows a twelve module washing apparatus **10**H with an alternate pulse flow that uses two or more pulse flow streams and having long distance incompatibility avoidance for incompatible batches, pH sensing and conductivity sensing. In cases of white vs. colored fabric articles separated by empty pocket, an alternate pulse flow can be provided which provides separate streams of counterflow water so that the counterflow for the colored downstream linen does not contact the white linen at the front of the machine.

In FIG. **20**, two finish modules **11**, **12** are provided for optional starching. In FIG. **20**, tank **26** has pumps **149**, **152** and a third pump **167**. Line **151** branches at tee fitting **168** to lines **169** (discharging to module **8**) and line **170** (discharging to module **9**). Third pump **167** discharges to line **169** which has tee fittings at **171**, **172**, **173**. Valves are provided on opposing sides of tee fittings **172**, **173** so that hot water at **174** or tempered water at **175** can be selectively added to an

alternate pulse flow header **176** or **177**. Alternate pulse flow header **176** enables water to be added to any one of modules **1**, **2**, **3**, **4**, **5**, **5**, **6**, **7** or **8** via a valved branch line **178**. As with FIGS. **1-5**, each module has a valved drain line and counterflow lines that connect a module (e.g., module **9**) to a previous module (e.g., module **8**). Line **177** has valved branch lines **180**, **181**, **182**.

An incompatible batch normally refers to a classification of linen which can be a different color than linen in downstream modules. For example, if red table linen is in modules **1** to **10** and the next classification of linen to enter the tunnel is white, the counterflow water used for the red table linen cannot be used for the white linen. Different counterflow streams are thus provided, described herein as "alternate pulse flow". Because the press water extracted from the red table linen normally flows to the PulseFlow tank, this water has to be diverted to sewer using the valves **60** (Closed) and **61** (Open), as seen in FIG. **4**B. The programming feature in the controller to operate these valves is called "Long Distance Incompatibility". FIGS. **20-24** all provide such "alternate pulse flow" with multiple sources of counterflow or multiple pulse flow headers.

In FIG. **21**, a twelve module washing apparatus **10**I provides an example of long distance incompatibility avoidance wherein white linen or textile articles follow colored linen or textile articles, an empty pocket provided at module **6**. Colored textile articles or colored linen are in modules **7-12** in FIG. **21**. White linen or textile articles are in modules **1-5** in FIG. **21**.

FIG. **21** is similar to FIG. **20**, but provides an "empty pocket" (at module **6** in FIG. **21**) which separates colored fabric articles from white fabric articles.

In FIG. **22**, washing apparatus **10**J provides an eight module washing apparatus wherein low temperature washing follows high temperature washing of white linen or white textile articles. In FIG. **22**, modules **1** and **2** are low temperature (e.g., 50° C.). Modules **2-8** are high temperature (e.g. 75° C.).

In FIG. **23**, modules **1-3** are low temperature white linen or textile articles wherein modules **4-8** are high temperature white linen or textile articles. In FIG. **24**, colored linen articles in modules **1-2** follow white linen articles in modules **3-8**.

In FIGS. **22**, **23**, **24** an additional tank **185** is provided. Tank **26** is for white fabric articles while tank **185** is used for colored fabric articles. Each tank **26**, **185** has a water or fluid source **157**. Header **186** receives flow from tank **185** and pump **188**. Header **187** receives flow from tank **185** and pump **189**. Line **190** receives flow from tank **26** and pump **152**. Line **191** receives flow from tank **26** and pump **149**. Line **190** transmits fluid from tank **26** to hopper **14**. Header or line **191** connects with each of a plurality of branch flow lines **192**. Each branch flow line **192** discharges to a module **1**, **2**, **3**, **4**, **5**, **6**, **7** or **8**. The branch flow lines **192** can be valved flow lines.

Header or flow line **186** connects with each of a plurality of branch flow lines **193**. Each branch flow line **193** can be valved. Each branch flow line **193** discharges to a module **1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**. In FIG. **22**, low temperature white linens follow high temperature white linens. In the example of FIG. **22**, only modules **1**,**2** are low temperature (e.g., 50° C.). Modules **3-8** are high temperature (e.g., 70° C.).

In FIG. **23**, the same arrangement of FIG. **22** is shown but after a transfer where the low temperature of module **2** has transferred to module **3** and the low temperature of module **1** has transferred to module **2**.

FIG. **24** is similar to FIG. **22** but colored fabric articles replace the low temperature white fabric articles of FIG. **22**. The high temperature white fabric articles of modules **2-8** of FIG. **22** are just white fabric articles in FIG. **24**.

The following is a list of parts and materials suitable for use in the present invention.

PARTS LIST

Part Number	Description
1	module
2	module
3	module
4	module
5	module
6	module
7	module
8	module
9	module
10	module
10A	textile washing apparatus
10B	textile washing apparatus
10C	textile washing apparatus
10D	textile washing apparatus
10E	textile washing apparatus
10F	textile washing apparatus
10G	textile washing apparatus
10H	textile washing apparatus
10I	textile washing apparatus
10J	textile washing apparatus
11	tunnel washer
12	inlet end portion
13	outlet end portion
14	hopper
15	discharge
16	soiled linen arrow
17	arrow
18	arrow
19	press/extractor
20	shuttle
21	dryer
22	transport
23	finishing station
24	extractor reuse tank
25	linen/fabric articles
26	pulse flow tank
27	conductivity sensor
28	conductivity sensor
29	conductivity sensor
30	influent flow line
31	flow meter
32	valve
33	valve
34	valve
35	flow line
36	valve
37	flow line
38	pump
39	valve
40	flow meter
41	valve
42	valve
43	sewer
44	flow line
45	pump
46	valve
47	flow meter
48	flow line
49	pump
50	influent flow line
51	flow meter
52	tee fitting
53	flow line
54	flow line
55	valve
56	valve
57	valve
58	pump
59	valve
60	valve
61	valve
62	sewer
63	valve

-continued

PARTS LIST	
Part Number	Description
64	valve
65	flow line
66	flow line
67	tee fitting
68	flow line
69	pump
70	flow meter
71	tee fitting
72	flow line
73	ironer
74	chest
75	roller
76	arrow
77	dotted line
78	arrow
79	cold water source
80	hot water source
81	flow line
82	Tee-fitting
83	valve
84	flow meter
85	valve
86	Tee-fitting
87	Tee-fitting
88	flow line
89	valve
90	flow line
91	valve
92	flow line
93	flow meter
94	valve
95	Tee-fitting
96	valve
97	Tee-fitting
98	valve
99	flow meter
100	flow line
101	pump
102	flow line
103	flow line
104	flow line
105	Tee-fitting
106	Tee-fitting
107	Tee-fitting
108	Tee-fitting
109	flow line
110	flow line
111	flow line
112	flow line
114	valve
115	valve
116	valve
117	valve
118	valve
120	chemical dispenser
121	water header
122	pump
123	fill valve
124	fill valve
125	fill valve
126	fill valve
127	flow line
128	sewer
129	drain valve
130	drain valve
131	drain valve
132	counterflow valve
133	counterflow valve
134	counterflow valve
135	counterflow valve
136	valve
137	valve
138	valve
139	valve
140	arrow

-continued

PARTS LIST	
Part Number	Description
141	counterflow line
142	counterflow line
143	counterflow line
144	valved drain lines
145	valved drain lines
146	valved recirculation line
147	transmitter
148	flow line
149	pump
150	branch line
151	line
152	pump
153	alkali detergent
154	chlorine bleach
155	antichlor solution
156	hydrogen peroxide
157	fluid source
158	valved flow line
159	sanitizing sour
160	sour solution
161	flow line
162	pump
163	pump
164	pump
165	pump
166	pump
167	pump
168	tee fitting
169	flow line
170	flow line
171	tee fitting
172	tee fitting
173	tee fitting
174	hot water source
175	tempered water source
176	alternate pulse flow header
177	alternate pulse flow header
178	valved branch line
179	ph sensor
180	valved branch line
181	valved branch line
182	valved branch line
185	tank
186	header
187	header
188	pump
189	pump
190	flow line
191	flow line
192	branch flow line
193	counterflow flow line

All measurements disclosed herein are at standard temperature and pressure, at sea level on Earth, unless indicated otherwise.

The foregoing embodiments are presented by way of example only; the scope of the present invention is to be limited only by the following claims.

The invention claimed is:

1. A method of washing fabric articles in a continuous batch tunnel washer, comprising the steps of:

a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and wherein one of the modules is an empty pocket that is drained of water, said modules including a first module next to the intake and a final module next to the discharge;

b) moving the fabric articles from the intake to the discharge and through the modules in a sequence beginning with the first module and ending with the final module;

c) adding a washing chemical to one or more of the modules;

d) rinsing the fabric articles by counter flowing liquid in the washer interior along a flow path that is generally opposite the direction of travel of the fabric articles in steps "b" and "c";

e) wherein one of the modules defines an empty pocket module that does not contain fabric articles and that is drained of fluid during step "d"; and

f) wherein the modules that are not empty pocket modules contain both fabric articles and fluid.

2. The method of claim **1** further comprising extracting excess fluid from the fabric articles after step "e".

3. The method of claim **2** wherein the empty pocket is moved from an upstream location to a downstream location.

4. The method of claim **1** wherein the empty pocket separates white fabric articles from non-white fabric articles.

5. The method of claim **1** wherein the empty pocket separates white fabric articles from colored fabric articles.

6. The method of claim **1** wherein the empty pocket separates higher temperature modules from lower temperature modules.

7. The method of claim **1** wherein there are multiple different counterflow streams in step "d".

8. The method of claim **4** wherein there are multiple different counterflow streams in step "d".

9. The method of claim **8** wherein one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses non-white fabric articles.

10. The method of claim **8** wherein counterflow stream in step "d" rinses white fabric articles and another counterflow rinses colored fabric articles.

11. The method of claim **6** wherein there are multiple different counterflow streams in step "d".

12. The method of claim **11** wherein one counterflow stream rinses higher temperature modules and another counterflow stream rinses lower temperature modules.

13. A method of laundering fabric articles in a continuous batch tunnel washer, comprising the steps of:

a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior;

b) moving the fabric articles and fluid in a first direction of travel from the intake to the discharge;

c) washing the fabric articles with a chemical bath in one or more of said modules;

d) rinsing the fabric articles after step "c";

e) providing an empty pocket in one or more of said modules that does not contain fabric articles and that is drained of fluid;

f) wherein the empty pocket is moved from one module to the next module in sequence, and in a direction from the intake towards the discharge; and

g) counterflowing liquid in the washer during step "d".

14. The method of claim **13** wherein the empty pocket separates white fabric articles from non-white fabric articles.

15. The method of claim **13** wherein the empty pocket separates white fabric articles from colored fabric articles.

16. The method of claim **13** wherein the empty pocket separates higher temperature modules from lower temperature modules.

17. The method of claim **14** wherein there are multiple different counterflow streams in step "d".

18. The method of claim **15** wherein there are multiple different counterflow streams in step "d".

19. The method of claim **18** wherein one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses non-white fabric articles.

20. The method of claim **18** wherein one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses colored fabric articles.

21. The method of claim **16** wherein one counterflow stream rinses higher temperature modules and another counterflow stream rinses lower temperature modules.

22. A method of washing fabric articles in a continuous batch tunnel washer, comprising the steps of:

a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and wherein one of the modules is an empty pocket that is drained of water;

b) moving the fabric articles and a volume of liquid from the intake to the discharge and through the modules in sequence;

c) adding a washing chemical to one or more of the modules;

d) rinsing the fabric articles by counter flowing liquid in the washer interior along a flow path that is generally opposite the direction of travel of the fabric articles in steps "b" and "c"; and

e) wherein one of the modules defines an empty pocket module that does not contain fabric articles and that is drained of liquid during step "d", and

f) wherein the empty pocket module moves from one module position to another module position.

23. The method of claim **22** further comprising extracting excess fluid from the fabric articles after step "e".

24. The method of claim **22** wherein the empty pocket is moved from an initial upstream location to downstream modules that are downstream of said initial upstream location.

25. The method of claim **22** wherein the empty pocket separates white fabric articles from non-white fabric articles.

26. The method of claim **22** wherein the empty pocket separates white fabric articles from colored fabric articles.

27. The method of claim **22** wherein the empty pocket separates one or more higher temperature modules from one or more lower temperature modules.

28. A method of laundering fabric articles in a continuous batch tunnel washer, comprising the steps of:

a) providing a continuous batch tunnel washer having an interior, an intake, a discharge, and a plurality of modules that segment the interior and including at least one intake module and at least one final module;

b) moving the fabric articles in a first direction of travel from the intake to the discharge;

c) washing the fabric articles with a chemical bath in one or more of said modules;

d) rinsing the fabric articles after step "c";

e) providing an empty pocket in one or more of said modules that does not contain fabric articles and that is drained of fluid;

f) wherein the empty pocket is moved one module at a time starting at the intake module and ending at the final module, and in a direction from the intake towards the discharge; and

g) counterflowing liquid in the washer during step "d".

29. The method of claim **28** wherein the empty pocket separates white fabric articles from non-white fabric articles.

30. The method of claim **28** wherein the empty pocket separates white fabric articles from colored fabric articles.

31. The method of claim **28** wherein the empty pocket separates higher temperature modules from lower temperature modules.

32. The method of claim **28** wherein there are multiple different counterflow streams in step "g".

33. The method of claim **32** wherein one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses non-white fabric articles.

34. The method of claim **32** wherein one counterflow stream in step "d" rinses white fabric articles and another counterflow stream rinses colored fabric articles.

35. The method of claim **32** wherein one counterflow stream rinses higher temperature modules and another counterflow stream rinses lower temperature modules.

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